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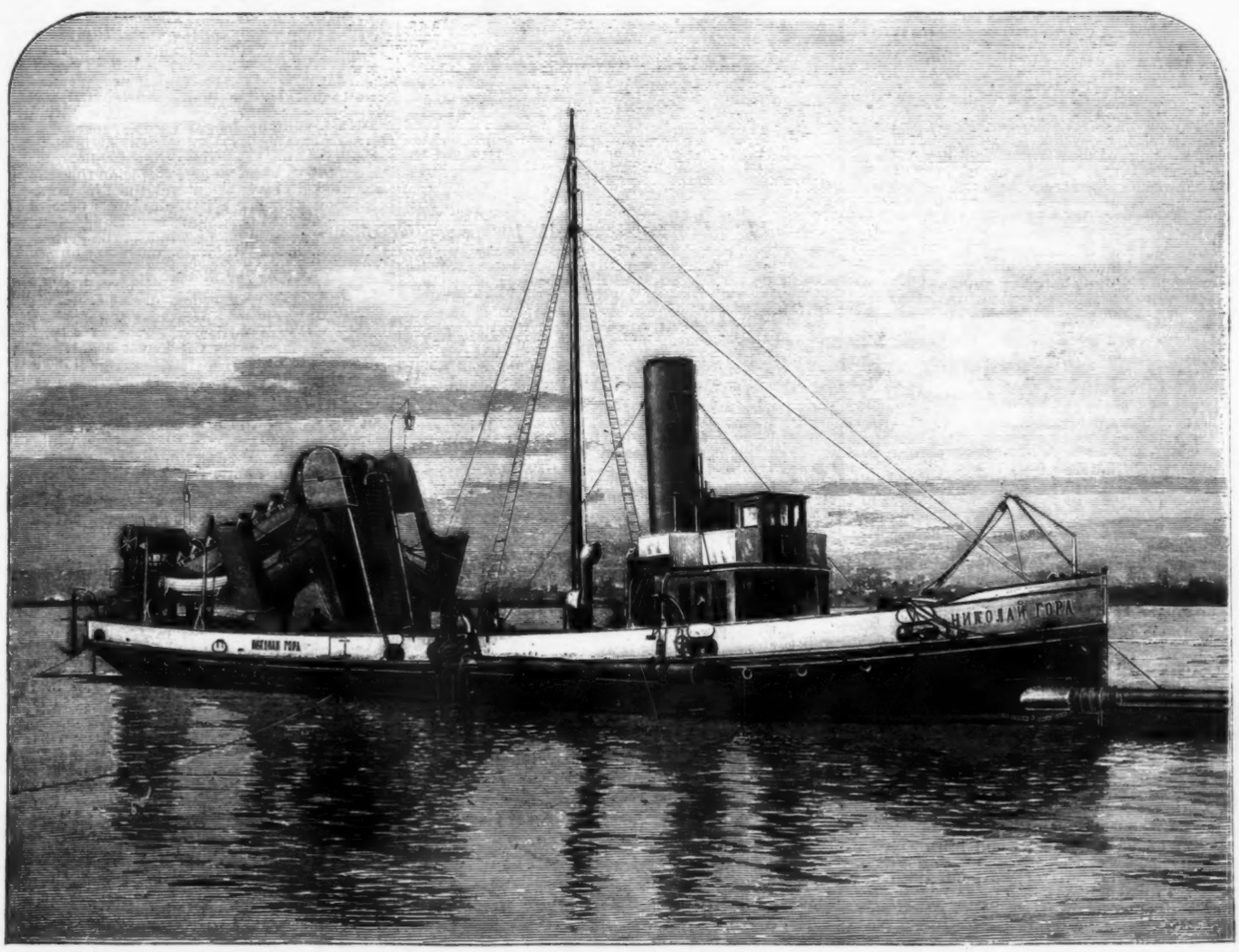
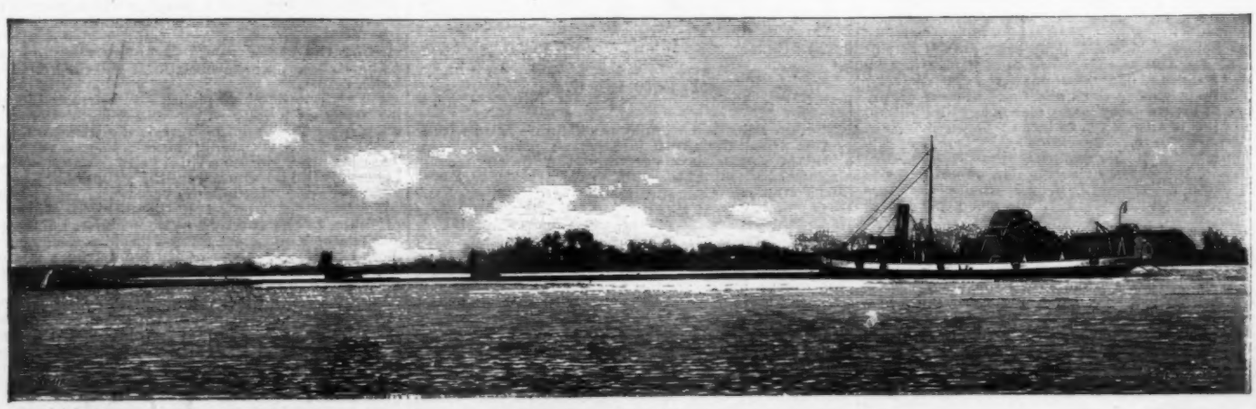
A SUCTION AND BUCKET DREDGER.

THE dredger of which we reproduce two photographs has been constructed by Messrs. A. F. Smulders, of Rotterdam, for use in the ports of the Sea of Azov. It is a suction and bucket dredger, and is provided with two centrifugal pumps for discharging the material dredged up either into barges brought alongside or directly on to the banks. The vessel is 151 ft. long by 27 ft. 3 in. wide, and is 10 ft. 6 in. deep. The maximum draught is about 7 ft. and the speed when fully loaded 8·5 knots. The vessel is constructed in accordance with the requirements of the first class of the Bureau Veritas. It can dredge to a depth of 22 ft. under water, and cuts its own way in the banks. The principal framework of the dredging apparatus is of tubular construction, made of plate 30 in. thick, and angles 3 in. by 3 in. by 0·4 in. The sternward feet of the frame are carried to the bottom of the vessel, the others rest upon a stout beam at the level of the deck. The dredging ladder passes centrally through the vessel, which is divided at the stern for this purpose. It is propelled by twin screws driven by two compound surface condensing reversing steam engines, each of 200 horse power—French. The same engines work the two discharge pumps. The high pressure cylinders are 15 in. diameter, the low pressure cylinders 26¼ in. in diameter, and the stroke is 15¾ in. The dredging ladder is driven by a similar engine. Two marine boilers supply steam at seven atmospheres for these engines. The total heating surface is about 2,300 ft. These boilers, and a small vertical boiler for providing the electric light, etc., are constructed of mild Siemens-Martin steel, and conform with the dimensions required by the Bureau Veritas. At port and starboard there are coal bunkers of 1,765 cubic feet capacity.

The discharge pumps can discharge about 8,830 cubic feet of sand or sandy mud per hour at a distance of 550 yards, raising it to a height of 5 ft., between the discharge orifice and the water level. These pumps will also raise spoil from a depth of 22 ft. by means of a tube lowered at the side of the vessel. Under these conditions it can raise and deliver into barges alongside or at a distance by means of floating pipes at least 8,830 cubic feet of sand per hour. The suction tube can be withdrawn entirely from the water, so that no resistance is offered to the sailing of the vessel.

On the deck is situated all the necessary maritime paraphernalia, and the hoists for raising the dredging ladder. The dredges are lighted exteriorly by two arc lamps, and within by incandescent lamps, and the cabins are heated by steam pipes.—The Engineer.





SUCTION AND BUCKET DREDGER.

[Continued from Supplement, No. 1133, page 18107.]

PERPETUAL MOTION.—IV.*

The celebrated astronomer, James Ferguson, F.R.S., devised the machine illustrated in Fig. 17. It is but fair to state, however, that the machine was designed to show the fallacy of perpetual motion schemes. Ferguson never believed it would move, but maintained that its immobility was a full demonstration of the utter impossibility of a self-moving device.

The axle is placed horizontally, and the spokes turn in a vertical position. The spokes are jointed, as shown, and to each of them is fixed a frame in which a weight, D, moves. When any spoke is in a horizontal position, the weight, D, in it falls down, and pulls the weighted arm, A, of the then vertical spoke straight out, by means of a cord, C, going over the pulley, B, to the weight, D. But when the spokes come about to the left hand, their weights fall back and cease pulling, so that the spokes then bend at their joints and the balls at their ends come nearer the center on the left side. Now, says Ferguson, "as the balls or weights at the right hand side are farther from the center than they are on the left, it might be supposed that this machine would turn round perpetually. I have shown it to many who have declared it would; and yet, for all that, whoever makes it, will find it to be only a mere balance. I leave them to find out the reason."

An old note informs us that "between the years 1760 and 1780 London abounded with perpetual motion seekers and their public exhibitions." Ferguson himself, a mechanician and inventor, would, no doubt, visit many of them, and would see "schemes ingenious, curious, and specious." He did not believe it possible to produce perpetual motion by any contrivance which required the motive power to be within itself (all external agents, such as that of a never-failing stream, the ever-varying pressure of the atmosphere, etc., being ignored). Yet, notwithstanding that, in 1770 he devised this plan for perpetual motion. In his "Commonplace Book," we find a fine pen and ink drawing of his scheme, which he designates as "the most rational scheme," but at the same time declares it to be "downright nonsense." At the conclusion of it he writes: "Whoever makes it will find that it is a mere balance;" from this it may be inferred that the machine was never made—never having had any other existence than that on paper.

W. Stephen claims our notice for drawings which he has left us of his designs for perpetual motion through applications of magnetism, and also of capillary attraction, which we can, however, only treat as early misconceptions, and offer them as a warning against pursuing similar attempts, for it is evident that if such schemes as those were capable of proving anything, the proof could only relate to the perpetuity of the agent, and not of the mechanism sought. A feather retained in a constant current of air would prove quite as much, that is, the constancy of the current as opposed to the inconstancy of the mechanical arrangement when rendered independent of such external agency. Stephen's sketches occur on the paper lining of the backs of a small quarto, entitled "Le Machine," by G. Branca, 1629, in the English Patent Office Library, having a fly leaf inserted on which is written, "W. Stephen's Book, March 10th, 1799."

His first figure, Fig. 18, has the following written on one side of it: "Motion by Magnetism. W. S.—Rep: per duobus N idem tempore quod cessit Attr: apud ☞ et sic aliter et de etc."

That is, the repulsion is twice through N in the same time that the attraction ceases at the ☞, and so on the contrary. This notice is obscure enough, but the next, Fig. 19, marked "Magnets at the end of spiral springs," appears without comment. We can only surmise, therefore, that Stephen expected that the magnet, N, on attracting an opposite magnet, or steel bar, would overweight the wheel, and thus continually present one after the other in succession, in like manner, thereby causing a continuous rotation!

From the works of the Hon. Robert Boyle, vol. v, page 71, we copy an historical account of a strangely self-moving liquor:

An ingenious teacher of mathematics, having occasion to make a composition for a new fire engine, whereof he was to show his Majesty a trial, mingled divers ingredients in an earthen pot over kindled coals; but could not or did not do it so warily, but that the matter took fire, and began to blaze furiously, which obliged him to stifle the blaze as hastily as he could; and having removed the vessel from the fire and suffered it to grow cold, when afterward he came to look upon it, to see if what remained might be of any use to him, he was surprised to find it variously and briskly moved. Wherefore, having set it aside, to be sure that it might be thoroughly cold, he, after some hours, visited it again, and found it move as before; and having cast store of seeds upon it, to see if the liquor would move them also, the bituminous part of it connected them into a kind of thick scum, that covered most of the superficies, but yet left some intervals in which the liquor appeared, and discovered that it continued its motions. Two days after, the engineer discoursing with me of this fire work, about which he had advised with me before, told me, among other things, of this odd accident. And when I asked him if the motion continued still, and had been answered affirmatively, though it was then a dark night and ill weather, my diffidence or my curiosity made me engage him to send for the pot as it was, partly to be sure of the matter of fact and partly to try if the knowledge I had of the ingredients, which he had before told me, would afford any hint of the cause of so odd an effect; a like to which in kind, though not in degree, I had many years before devised, and successfully practiced, the way of producing.

The vessel being come, though the hasty transportation of it seemed to have sufficiently disturbed it, there did appear manifest signs of such a motion as the engineer had ascribed to it; and, therefore, he being willing to leave it with me, I caused it to be set aside in a laboratory, where some furnaces kept the air constantly warm, and did there and elsewhere, at different times, look heedfully upon it, now and then displacing or quite taking off some of the thick scum that too much covered the surface of it, and by this means I had the opportunity to take notice of several phenomena, whereof these are the chief:

1. I observed that the motion of this liquor was not only brisk, but very various, so that having loosened some small portions of the scum, one of them would be carried toward the right hand for instance, and another toward the left, at the same time.

2. Where the liquor first came out from under the scum, it seemed to move the most briskly, flowing almost like a stream whose motion upward had been checked, and, as it were, reverberated by that incumbent obstacle.

3. Several motions in this liquor were the more easy to be observed, because, though it were dark, yet it was not uniform; consisting in part of oily and bituminous ingredients, which, though they seemed to have but one common superficies with the rest of the liquor, yet, by their colors and power of vigorously reflecting the light, they were easily enough distinguishable from

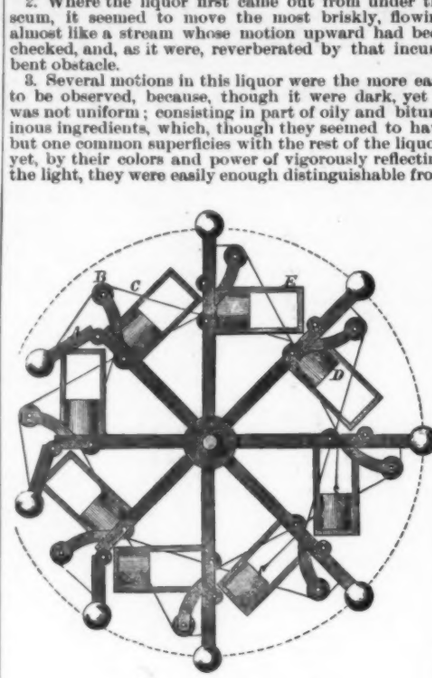
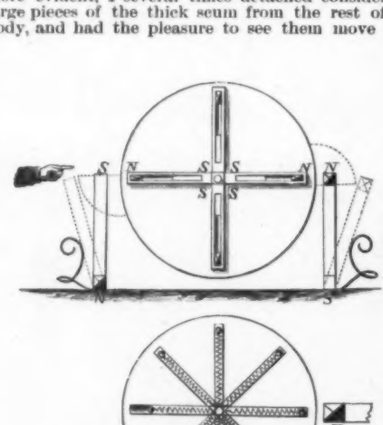


Fig. 17.

the rest. And I often observed that some of these unctuous portions of the matter, emerging to the surface of the liquor, though perhaps at first one of them would not appear bigger than a pin's head, yet, in moving forward, it would at the same time diffuse itself circularly, and make, as it were, a great halo, adorned with the colors of the rainbow, and so very vivid as afforded a very pleasant, and at first surprising spectacle; these phantasms often nimbly succeeding one another, and lasting till they lost themselves against or under the thick scum.

4. The motions of this odd liquor were not only various, but frequently vortical; to be satisfied of which, I sometimes put short bits of straw, or fragments of some such like stuff, upon the discovered part of the surface of the liquor, by which they were carried toward very distant, if not opposite, parts of the vessel at the same time. But to make the vortical motion more evident, I several times detached considerably large pieces of the thick scum from the rest of the body, and had the pleasure to see them move both



Figs. 18 and 19.

with a progressive motion in crooked lines, and with a motion about their own middlemost parts. All this while the liquor, whose parts were thus briskly moved, was actually cold, as to sense.

5. To observe what the presence, or absence, of the free air would do to this liquor, I caused many spoonfuls of it, with some of the scum, to be put into a cylindrical glass, which, though large itself, had a neck belonging to it that was but about the bigness of one's thumb, that it might be well stopped with a cork. But having, by this means, kept the free air from having a full and immediate contact with the whole surface of the mixture, as it had when that mixture lay in the wide mouthed vessel, I could not perceive the liquor to move to and fro, no, not though the orifice of the neck were left open; whereas, having, at the same time, poured some of the liquor into a very shallow and wide mouthed vessel, called in the shops a clear caked glass, it moved rather more than less nimbly and variously than in the great earthen pot (which yet was of the same shape), and showed us many of those vivid and self-dilating circles that have been mentioned in the third number; and these, by the fineness of their colors and the quickness wherewith they succeeded one another, afforded a delightful spectacle as long as I stayed to observe the liquor.

6. Though the motions of the hitherto mentioned liquor did not seem to be always equally brisk, yet they appeared to continue manifest and various in some diversities of weather, as to cold and heat, and when I looked on it by candle light as well as by daylight; and when, not being well enough to visit it myself, I sent one purposely to look upon it, about ten o'clock at night, he brought me word that it continued to move as formerly, and so it has done for ten days; and how much longer it will continue to do so, time must determine.

Postscript.—Some time after the foregoing account had been written, when I came to look upon the liquor (which in the mean time had been several times viewed, and appeared to retain its motions), I found, to my trouble, that somebody's impertinent curiosity and heedlessness had cracked the lower part of the earthen pot; at which overture, the liquor, though not the scum, was run out; which had put a period to our observations, but that, foreseeing that such an accident might happen, I had long before taken out some spoonfuls of the liquor, and kept it close stopped in a vial. By this means I had the opportunity to observe that, when I poured out the liquor into a wide mouthed vessel, it would move as before, though this were done some weeks after it had been put up. And I remember that long after, having one day received the honor of a visit from a foreign minister, who was an inquisitive person and a man of letters, we chanced, among other things, to talk of the liquor; and though it were scarce to be hoped that it could retain any of its motive virtue, yet, to gratify his curiosity, and that of some ingenious men there present, I caused the vial to be brought, and having unstopped it, I poured out the liquor into a convenient shaped vessel, in which, after we had suffered it to rest awhile, they were delightfully surprised to see it move (though not, in my opinion, quite so briskly as before), yet very manifestly and variously. This encouraged me to think it possible that it might retain some motion, though but languid, seven or eight weeks after; and therefore, on the 25th of July, I looked upon it again, and having caused it to be poured into a china cup, it manifested, at first, a brisk and various motion; but this, after awhile, did so slacken that I began to have some suspicion that the motion it was put into by effusion and the first contact of the air might have given it the greatest part of its agitation. But this being but suspicion, I put the vessel into divers postures in a window, the better to discover the true cause of this phenomenon; but while I was busy about this, which engrossed my attention, a mischance overturned the cup, and, by throwing down the liquor, put an end to my speculation; yet this mischance hindered me but from observing how long the odd agitation of our liquor would have continued, but not from finding that it lasted a great while; for I showed it to the foreign minister about or after the beginning of June, that is, about five months or more after the liquor was first observed to move.

Innumerable are the devices by which men have sought to make wheels permanently retain an excess of weight on one side of their centers, while revolving. Our engraving, Fig. 20, illustrates one of these absurd attempts. An endless chain, A, passes over pulleys, B, over the idler pulley, D, and under the idler pulley, C. It is expected that the increased weight of the greater length of chain on one side of the upper pulley, B, will more than counterbalance the weight of the chain on the other side, and also compensate for friction created by the pulleys, and so impart a constant rotation to the pulleys and fly wheel.

The device described is, however, outdone by the one shown in Fig. 21, prepared in 1829, by a correspondent of the Mechanics' Magazine.

This was to be a self-moving railway carriage. The genius who devised this machine thus writes in regard to it:

"In treating of perpetual motion—'that grand secret for the discovery of which those dictators of philosophy, Democritus, Pythagoras, Plato, did travel unto the Gymnosophists and Indian priests'—it would add considerable interest to give some account of its early history. Regarding the fallibility of every contrivance hitherto planned or experimented upon, we may gather sufficient from the writings of Bishop Wilkins alone. The 'little world' of Paracelsus and his followers; the planetarium invented by Cornelius Dreble, for King James; the 'magnetical globe of Terella,' suggested by Pet. Peregrinus, with the wheel that he, Taisner, and Cardan thought might be kept in motion by 'pieces of steel and loadstones,' are, like the Bishop's own wheel and plummets, and his application of Archimedes' screw, inadequate to the grand end for which they were designed.

"Without enlarging on this head, we shall proceed with the description of a machine which, were it possible to make its parts hold together unimpaired by rotation or the ravages of time, and to give it a path encircling the earth, would assuredly continue to roll along in one undeviating course till time shall be no more.

"A series of inclined planes is to be erected in such a manner that a cone will ascend one (its sides forming an acute angle), and, being raised to the summit, descend on the next (having parallel sides), at the foot of which it must rise on a third and fall on a fourth, and so continue to do alternately throughout.

"The diagram is the section of a carriage, with broad, conical wheels, resting on the inclined plane. The entrance to the carriage is from above, and there are ample accommodations for goods and passengers. The most singular property of this contrivance is, that its speed increases the more it is laden; and when checked on any part of the road, it will, when the cause of stoppage is removed, proceed on its journey by mere power of gravity. Its path may be a circular road formed of the inclined planes. But, to avoid a circuitous route, a double road ought to be made. The carriage not having a retrograde motion on the inclined planes, a road to set out upon, and another to return by, are indispensable.

"I am indebted to a much respected friend for the

* Reprinted from the Scientific American, 1870-71.

hint of this means of effecting a veritable perpetual motion."

"The Perpetual Motion Hunter" is the title of an article in the Imperial Magazine, vol. 6, 1824:

It gives me much pleasure (says the writer) to observe that you notice scientific subjects; you are very right in so doing, as it will not only give variety, but add considerably to the value of your very useful miscellany. It is my humble opinion that such a procedure is infinitely better than filling it with the splenetic effusions of angry minds, the ebullitions of disappointed envy, or, what is worse, dealing out large portions of scandal, and making use of personalities to wound virtuous sensibility, as is the constant practice in some similar publications.

I am now, sir, an elderly man, and am sorry to inform you that I have lost much valuable time, and, of course, money, too, from having been infected, in the early part of my life, with the vanity of hunting after that ignis fatuus called the "perpetual motion." Common report informed me that it would immortalize the name of the inventor; that by it the longitude would be discovered; and that, on this account, the British Parliament had offered a premium of ten thousand pounds for its discovery! This was something like assailing a man at all points at once; the acquirement of such prodigious fame flatters his vanity; and the "ten thousand pounds" could be looked upon in no other light than as the reward of distinguished genius!

Under these impressions I began my career, and pursued it with an ardor which, in any other case, could not have failed to insure me success. I read with the greatest avidity all the accounts of such machines I could anywhere meet with. For a short time I was amused with the ball of iron and the magnet, mentioned in Bishop Wilkins' "Mathematical Magic." I afterward studied the properties of Orffyreus' wheel, which, as Gravesande informs us, continued in rapid motion for two months; at the end of which period it was stopped, he says, to prevent the wear of materials. This astonishing wheel was, you know, destroyed by the inventor, soon after the time of the above mentioned experiment. I endeavored with all my might to recover the long-lost secret, and success partly crowned my efforts; for, after a great deal of wearisome labor, I constructed a machine which I then believed would amply compensate the loss which the crazy philosopher had occasioned, when, in a fit of frenzy, he dashed it to pieces. The delight which Newton felt, on discovering the law of gravitation, did not exceed mine when I found that my machine would answer the intended purpose. 'Tis true, it would not put itself in motion—but what then? It was sufficient for the purpose if it would move perpetually when put in motion; and at that time, like many others, I did not quite understand how many requisites were necessary in order that a machine might become a "perpetual motion."

You can scarcely imagine how my heart palpitated when I sent off a description of this, my first invention, to the Board of Longitude. It was a machine which I had no doubt would determine the longitude, both at sea and land, with the greatest ease and accuracy. During the first week, my nightly slumbers were frequently broken by the violent perturbations of my mind; and my day dreams almost continually represented to me the postman knocking at my door with the wished-for letter that was to crown all my hopes. So certain was I of success that I actually began to look about for an estate which the ten thousand pounds were to purchase; for, in my mind's eye, I had it already in my grasp. The humble occupation I had till then followed I now looked upon with disgust; and I saw myself at once elevated to opulence and fame. I waited with patience—yes, Mr. Editor, with all the patience I could muster—but no letter arrived. However,

"Day presses on the heels of day,
And moons increase to their decay."

After a few weeks, my mind recovered its wonted serenity, and in about three months more my machine was as free from any violent perturbations as my mind, for at the end of that period, it had completely lost all power, either of perpetuating or continuing its motion. This circumstance occasioned me some uneasiness; and I was not much amused with the taunting remark of one of my friends, who on viewing it exclaimed, "Well! it is a perpetual motion still!" At the end of nine months, I received a latter from the Secretary of the Board of Longitude, informing me of what I already knew—namely, that my machine would not answer.

It is now carefully stowed in my brother Jonathan's garret, at Brigg, in Lincolnshire, where it may be seen by all who are curious in such matters.

I now turned my mind into a different channel. I thought it possible that the object of my search might be accomplished by means of some of the fluids. I considered, with care, the almost continued oscillation of the mercury in the tube of the barometer; but I could deduce from this motion no practical result. I afterward endeavored to turn the tides to some account; but I failed here also. At length, after turning my mind in a variety of ways, as I was one day reading an account of the rise of water in capillary tubes, it at once occurred to me that, as the water rises in such a tube to more than an inch above the surface of the water in the vessel in which the tube is immersed, if I placed the tube in an inclined position, the water would run over its top; and as it would fall into the same vessel, the motion thus produced would be perpetual. At this moment my mind was again agitated; I exclaimed, like Pythagoras, "I have found it! I have found it!" I now supposed myself to be as great a man as any Pythagoras that ever lived. I did not, however, run out, like him, naked into the street; but I remember the discovery was made in the winter season, when I was warmly and comfortably clothed. Had it been in the summer, I cannot tell what might have happened.

I soon procured a capillary tube, and proceeded very carefully to make the experiment; but the water did not flow! Well, said I, this is curious; but a siphon will run: that the water does not run from the top of the tube is owing to the pressure of the atmosphere upon it. I now ordered a capillary siphon, and was again disappointed; for the sluggish water, as if envious of my fame, still refused to move.

Having recovered a little from the stupor into which I had been thrown by the failure of another of my schemes, it occurred to me that if I employed a siphon to carry water over the bank of a river that communicated with the sea, the siphon would run if the outer leg on the outside of the bank was longer than the inner leg; and because the water would find its way into the ocean, and be brought back by the process of evaporation, which is constantly going on, the motion would be perpetual. I could not, however, employ this method to discover the longitude, either at sea or land, and, of course, I was not entitled, from this invention, to the ten thousand pounds.

Another of my machines consisted of two wheels, A and B; the wheel, A, had a number of buckets, at equal distances, round its outer rim. These buckets were so placed that they would each contain a ball of iron. Seven such balls were always on one side of the wheel,

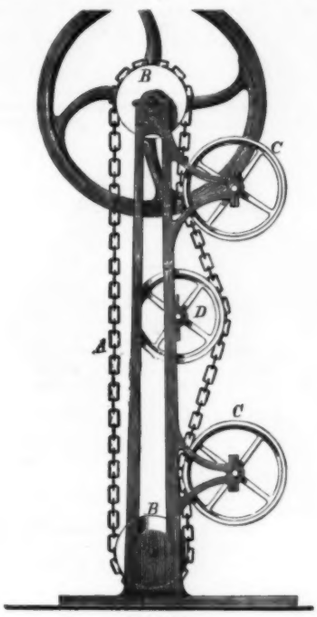


FIG. 20.

A, urging it downward; and one was in the inside of the wheel, B. When the wheel, A, had arrived in a certain position, the lowest ball fell out of its bucket, and rolled down an inclined plane, placed for that purpose, into the interior of B; and then it rolled down another inclined plane into the top bucket of the wheel, A, and so on. This machine had a very specious appearance, and was mistaken for a perpetual motion by thousands of well-informed persons. I need scarcely add that the persons I mention were ignorant of the laws of motion and the theory of mechanics. A similar machine was lately exhibited for a perpetual motion, and a great deal of money made by showing it to the good people of New York, in North America.

My last invention of this kind consisted of an iron wheel and four magnets, similar to the one exhibited some time back in Edinburgh and other places. As the wheel did not move uniformly, and as the power of the magnets soon began to diminish, I suspected it would ultimately fail, and abandoned it altogether. It is necessary to inform you that my modesty—or, rather, my honesty—would never permit me to exhibit any of my inventions for money, as I had always very strong

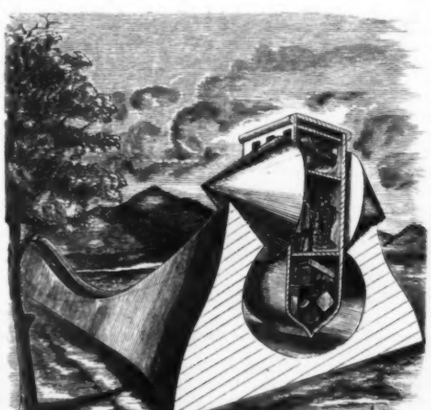


FIG. 21.

grounds of suspicion that they would not answer, and my suspicions were always verified in a short time. It was only after a great number of disappointments that I began seriously to think on the subject. I at first wondered how it happened that my schemes should always prove abortive; but I soon discovered that I was entirely ignorant of the theory of mechanics. Not long after, I had also the mortification to perceive that I had totally mistaken the specific nature of the machine which had been so long the object of my search; so that it would have been next to a miracle if I had found it. I now began in earnest to acquire a knowledge of the principles of natural philosophy, and I very soon found that I had begun at the wrong end of my business.

My misfortunes had created in me serious musings. Yes, said I, in all ages mankind have had some favorite object to pursue—a something bordering on the limits of impossibility. Astrology, or the foretelling of future events, was once the grand charm that led men astray. People are fond of prying into futurity. All men are naturally delighted with what is wonderful; and what pains do they take to deceive themselves! Astrology ruled with despotic sway during the reign of ignorance; but, as knowledge advanced, the chimera retreated; and the few votaries it has now left are ranked either among the most ignorant or the most knavish of all the human race.

Alchemy was another favorite pursuit. To be able to transmute the baser metals into gold was certainly an object of the greatest consequence, and now the discovery would be particularly desirable. There is no doubt that it would be liberally patronized by the ministers of state and the members of the British senate; because, if properly managed, it would enable them to pay off the national debt, and ease the good people of England of the intolerable burden of taxation. In case of such an event taking place, what joy would be diffused throughout the whole of this great empire! The people would be wealthy, and the ministers again able to create places and to give pensions ad infinitum. But I must return to my subject. The search after the perpetual motion is of the same nature as those of astrology and alchemy. It has long amused the ignorant and deceived the credulous; but men of science, properly qualified to judge of its merits, look upon it as a nonentity, and laugh at its proselytes as deluded creatures, who are pursuing a phantom of their own creation.

I have not much hope of being able to convince those persons who are in search of this shadow of a shade that their labors will be fruitless. I will proceed, however, to describe the machine they are endeavoring to construct. The perpetual motion is a machine which possesses within itself the principle of self-motion, and because every body in nature, when in motion, would continue in that state, it follows that every motion, once begun, would be perpetual, if it were not acted upon by some opposing force, such as friction, the resistance of the air, etc. In order, then, to produce a perpetual motion, we have only to remove all the obstacles which oppose that motion; and it is obvious that if we could do this, any motion whatever would be a perpetual motion. But how, let me ask, are we to get rid of these obstacles? Can the friction between two touching bodies be entirely annihilated?—or has any substance yet been found that is void of friction? Can we totally remove all the resistance of the air, which is a force continually varying? And does the air at all times retain its impeding force? They cannot be removed, then, so long as the present laws of nature continue to exist, and who will attempt to destroy them? Besides, it is a well known principle in mechanics that "no power can be gained by any combination of machinery, except there be at the same time an equal gain in an opposite direction;" and must there not be some absolute loss arising from opposing forces, as friction, etc.? How, then, can a perpetual motion be found by any combination of machinery? Another necessary circumstance is, that the motion of any such machine be uniform; for, if it accelerate, it will in time become swift enough to tear itself to pieces; if it retard, it will at length stop. Now, among all the numerous forces acting on machines—forces, too, which are continually varying according to known causes, and to the influence of which every machine is constantly liable—who is there so hardy as even to imagine that a machine can be constructed the motion of which shall be constant and uniformly the same?

There is one perpetual motion, and but one—that is, I know of but one—and that was constructed by Infinite Wisdom. The Divine Creator of the universe has balanced this earth with such exquisite art that its diurnal revolutions are performed so precisely in the same time that it has not varied the hundredth part of a second since the time of Hipparchus, which is now more than two thousand years.

All that we can hope is, that the beams of science will diffuse truth more generally through the world; for, otherwise, dreamers of every kind will continue to dream to the end of time.

(To be continued.)

THE WORLD'S GOLD PRODUCTION.

IT is only twenty years ago, says the New York Journal of Commerce, that an eminent European geologist startled the world by announcing the following conclusions: 1. That the production of gold in the future would have to depend mainly on the output from alluvial deposits. 2. That much more than one-half of the quantity of gold obtainable by the means hitherto employed had already passed through the hands of man. 3. That the time would certainly come, and probably after a few centuries, when the production of gold would cease to an extraordinary extent, and when that metal, on account of its ever-increasing scarcity, would cease to be able to maintain the economic position it had hitherto held. The figures of production seemed to sustain these conclusions. In 1871 the value of the gold mined throughout the world was about $127,000,000; by 1879 it had decreased to $116,000,000; in 1887 was within $106,000,000, and even in 1890 it fell short of $119,000,000. During this time the production of silver was advancing by leaps and bounds. Reckoned at its coining value, the world's production of silver in 1871 was $61,000,000; by 1879 it had touched $96,000,000; by 1887, $124,000,000; and in 1890 it was $162,000,000.

It was not only the discoveries of gold in South Africa that gave a new impulse to the world's production of that metal after 1887. The application of improved processes of separation, both mechanical and chemical, which had done wonders for silver production, was destined to accomplish still more notable results in the increased yield of gold. The cyanide process of gold extraction, which consists in dissolving the gold from ore, concentrates, or tailings by leaching (or agitation) with a dilute solution of cyanide of potassum and precipitating the gold with metallic zinc, dates from 1890. The cost of operating this process was originally $2.40 per ton of ore in bulk, but it was steadily reduced to $1.80 per ton, and has finally reached $1 per ton, and even lower. This and the cognate process of chlorination rendered it possible to work at a profit veins of gold in the sedimentary rocks whose existence, while not un-

known, was regarded as having no practical bearing on the supply of the precious metal. It is very largely due to the application of these processes that it has been possible so to utilize the refractory ores that the world's product of gold in the last seven years has grown from $130,000,000 in 1891 to $180,000,000 in 1894, and now to an estimated $240,000,000 in the present year.

To-day more than 60 per cent. of the world's production of gold is obtained from the solid rock—a proportion not likely to be seriously affected by the yield of British Columbian and Alaskan gravels. The mines of the Rand are producing at the rate of $12,000,000 more this year than they did last, and those of Australia promise to exceed last year's product by nearly $7,000,000. In both cases the source of supply is almost exclusively crude ores, whose reduction is a question of capital and labor applied in much the same systematic way as prevails in more familiar departments of mining industry. Thus, from being one of the most hazardous of enterprises, gold mining has become one of the safest possible pursuits. The fact has been quoted as indicating the change of public sentiment in regard to the working of the auriferous strata of the earth's surface that established dividend-paying gold stocks four or five years ago might be bought at prices netting the investor from 25 to 30 per cent., while at the present time these same stocks command prices at which the investor realizes only 10 or 15 per cent. In fact, gold mining is being rapidly raised from the level of pure speculation to that of legitimate industry, and as an expert authority has pointed out, with this change has come that careful attention to small economies and to minor improvements in methods and appliances which marks all sound industrial operations.

Under such conditions the only limit to the world's production of gold is the cost of extracting the metal from its baser accompaniments. A tremendous advance was made when the hitherto worthless pyrites which could not be treated by amalgamation were made to yield up their gold contents to chlorination, and when it became possible by the introduction of the cyanide process to obtain almost the last traces of gold from the "tailings" which had been hitherto treated as mere rubbish. The director of the United States mint has stated that under the improved processes of ore treatment only 5 per cent. of the gold is lost. This is not literally true, referring as it does only to the ore crushings ready for chemical treatment. There is scientific authority for the statement that there is a possibility of enlarged profits from increased efficiency equal to an increase of yield of from 15 to 25 per cent. over that attained by the processes in use. The possibility, however, of enlarged profits from the combined effect of reduced working cost and increased efficiency is not arbitrarily limited to any percentage. At the close of last year Mr. Becker, of the United States Geological Survey, found, after actual study of the conditions existing in the Transvaal, that the cost of working a ton of ore might be reduced to about 25 shillings, though the actual minimum was still considerably higher. According to a return of the average yield of ore made by the various companies operating in the Rand, it appears that the amount of gold extracted from a ton varies from 5 pounds sterling to 16 shillings and 6 pence. About a fourth of the companies show a yield per ton of over 42 shillings; there is another fourth below the average, running all the way down to 32 shillings; between that and the point where there appears to be no profit nearly another fourth are operated, and the remaining fourth seems to be worked, so far, either at a positive loss or without any profit at all. The fact remains that there is in the mines of the Transvaal at least $1,500,000,000 of gold yet to be extracted, and that this includes considerably less than one quarter of the known available supply of the world, even before the recent discoveries at Klondike.

ON A SLOW COMBUSTION ARC LAMP SUITABLE FOR FACTORIES AND STREET LIGHTING.*

By W. S. Squire, Ph.D., F.C.S.

According to Mr. W. H. Preece, one-half of the cost of arc lighting is due to the consumption and replacement of the carbons. If in respect of this expense an economy of 50 per cent. could be realized, an important step in advance would be made, still more so, if an economy of 75 per cent. could be obtained. The lamp I am about to introduce to your notice goes much further than that, as you will see presently.

In an ordinary arc lamp the consumption of carbons is usually at the rate of about 1¼ in. per hour—1 in. for the positive or upper carbon and ½ in. for the negative or lower carbon, or, say, 40 mm. per hour, both carbons included. This, of course, will vary somewhat, according to the amount of the current. The consumption of carbons in the new lamp (varying also with the strength of the current), and consuming the same amount of electrical energy as the ordinary arc lamp, will be from 1·20 to 2 mm. That is to say, only 5 per cent. of the consumption of the ordinary lamp—an economy of 95 per cent. As this result has been attained by means partly of a mechanical, partly of a chemical character, I thought it a fit subject to bring before a society occupied to a great extent with questions of chemical engineering.

The lamp was invented by an American named Jandus, born in Wisconsin, of Hungarian parents.

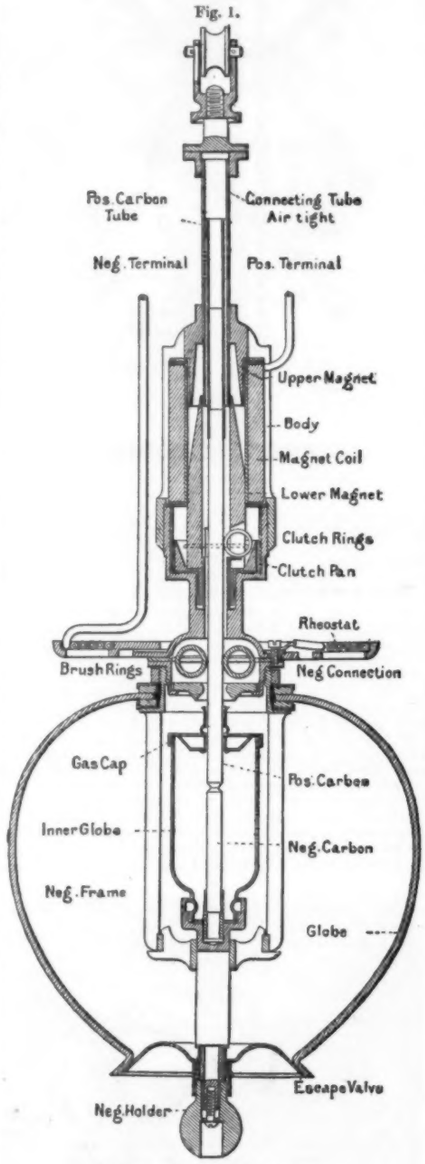
I propose in the first place to describe the mechanical construction of the lamp, giving you an opportunity of handling and examining the various parts. I will then have the parts put together, so that you may see the same lamp in action. While this is being done we can consider the chemical side of the question.

Fig. 1 represents the lamp in section. The current enters the lamp by the negative terminal, and then passes through a resistance which has the effect of reducing the voltage (which is in this room 108) down to 81. This is about double the voltage usual for arc lamps. It then passes by the insulated screw shown on the right hand to the lower carbon holder, and so to the lower carbon. It crosses the arc to the upper carbon. It leaves the carbon by the brush rings, and then goes through the magnet coil to the positive terminal.

* Paper read before the Society of Chemical Industry. From the Journal of the Society of Chemical Industry.

The magnet coil incloses two cast iron magnets, which I may call the male and female magnets. The female magnet is fixed, but the male is free to move up and down. These will have a tendency to attract one another, and when the current in the coil is strong enough to enable the induced magnetism to overcome the weight of the lower magnet this will rise, carrying with it the upper carbon. The effect of this will be to lengthen the arc, and by increasing the resistance, to diminish the current through the coil, and so arrest the further rise of the magnet. Matters thus remain in equilibrium until, by consumption of the carbon, the arc becomes longer, and the current thereby diminished. The lower magnet then begins to descend. It will be seen that both the fixed and the movable magnet are hollow, and that the upper carbon is not attached to either of them. How then does the movable magnet carry the carbon with it? This is one of the most ingenious contrivances in the lamp. There are three equidistant slots in the lower magnet. In each slot a brass ring is inserted, the rings being prevented from falling out by a wire passing round the magnet. The tendency of these rings is to fall together and clip anything passing in a downward direction, but they will allow anything to pass in an upward

Fig. 1.



INCLOSED ARC LAMP.

direction. By this means the carbon is firmly attached to the lower magnet.

If, however, the magnet drops so far that the rings come in contact with a brass plate cut out so as to fit into the slots in the magnet, they are lifted and rolled back so as to allow the carbon to slide down by its own weight between the rings; the moment the normal current is re-established the magnet rises, the rings clutch the carbon, and its further movement is arrested. It is in this way that the upper carbon is gradually fed forward.

A somewhat similar device is employed to make an electrical contact with the upper carbon by means of the brush rings. These do not clutch the carbon at all, but rest gently against it, and being hung in such a way that they are free to turn, they make electrical contact without opposing any sensible resistance to the movements of the carbon. Moreover, they are so placed that the electrical contact is at no great distance from the arc, so that the carbon offers a minimum of resistance, and it is also an unvarying resistance—a point of some importance.

As shown in the drawing, the arc is produced inside a small glass cup, which is closed at the top by the so-called "gas cap." This cap has a double duty to perform. In the first place it prevents to a considerable extent the escape of the gases resulting from the combustion of the carbons inside the cup. In the second place it provides for automatically extinguishing the lamp when the upper carbon is nearly exhausted.

The carbon passes freely through the aperture in the center of the cap, but the brass carbon holder cannot pass. As soon as this arrives at the cap the movement is arrested, the feed is stopped, the lamp is extinguished, and no harm can happen to the metal work.

Besides the small glass cup in which the arc is produced there is also an outer globe, which is so fastened by packing to the body of the lamp as to be quite air-tight. In this way a layer of highly heated gases is caused to float in the upper part of the outer globe upon the colder gases beneath. This tends to assist the action of the gas cap in keeping the air from the arc. Lastly, the outer globe is closed at the bottom by an escape valve, which opens to let out the gases when expanded by the heat of the arc. Of course, this valve is removed when the carbons are renewed.

It is evident that the arc is produced in a small chamber, to which the possible access of air is reduced to a minimum. Consequently, very little combustion of the carbons takes place. After the lamp has been at work for a short time, almost all the oxygen present in

Fig. 2.

INCLOSED ARC. OPEN ARC.

the glass cup has been consumed, and the gases in the cup are found to have the following composition:

Carbon dioxide	1·4
Carbon monoxide	23·6
Oxygen	2·7
Nitrogen	72·3
	100·0

The interior chamber is not, however, perfectly air-tight, and diffusion will occur between the gases in the interior chamber and those in the globe outside. Consequently, a very slow combustion of the carbons will go on, while, on the other hand, the gases produced in the interior chamber will diffuse into the outer globe. After some hours' burning the gases in the outer globe are found to have the following composition:

Carbon dioxide	0·8
Carbon monoxide	12·2
Oxygen	12·9
Nitrogen	74·1
	100·0

It is obvious that, in order to produce this effect, the tube in which the upper carbon, with its holder, slides must be perfectly air-tight, and the joint between the glass globe and the lamp must also be air-tight.

The result of this arrangement is that the carbons burn away very slowly, the consumption never exceeding 2 mm. an hour.

Using carbons of 13 mm. diameter, the upper one

OPEN AIR ARC. INCLOSED ARC.

having a length of 270 mm., or, say, 10⅝ in., and the lower one a length of 150 mm., or, say, 6 in., the lamp is found to burn—

	Hours.
With a current of 4 ampères	220
" " 6 "	160
" " 7 "	120

Consider what this means! When the ordinary arc lamps are used, a man must go up the post every morning and put in fresh carbons. In the case of a lamp burning 220 hours it will be necessary to renew the carbons, on an average, only once in three weeks, say, once a fortnight in winter and once a month in summer. This is not only a great saving in carbons but in wages as well.

The lamp which we have put together has now been burning for about 10 minutes, and the gases in the interior chamber or cup should have the composition I have indicated. I will quickly remove the lower carbon and cup. At the moment that I do so, the highly heated upper carbon as it passes out should set fire to the gases in the cup (experiment performed). You see the carbon monoxide burning with the characteristic blue flame.

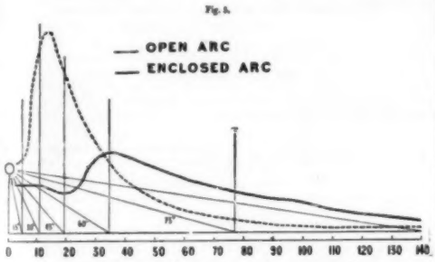
I wish to direct your attention to the way in which

these carbons burn. In the case of the ordinary arc lamp burning in air, the consumption of the positive carbon, as compared with the negative carbon, is as two to one. In the case of the Jandus lamp it is as four to one, so that the consumption of the lower carbon is practically a negligible quantity. Owing to the lower carbon, in the case of an arc produced in air, burning away at about half the rate of the upper carbon, which is in all lamps fed up to the arc, the point of light is gradually lowered in the globe, so that any devices, such as reflectors, or holophane globes, soon cease to act properly unless there is a special compensating mechanism, usually both complicated and costly. Owing to the very small consumption of the lower carbon in this lamp, the luminous point is practically fixed without any compensating mechanism whatever.

There is also a considerable difference between the shape of the ends of the carbons burning in air and those burning in the Jandus lamp (see Fig. 2). In the Jandus lamp they remain very nearly flat, slightly convex on the negative, slightly concave on the positive. When the carbons burn in air the negative is very distinctly pointed, while there is a sort of crater formed on the positive. This is generally attributed to a transfer of the particles of carbon from one pole to another, but, of course, the forms produced in this way must be perpetually broken down and obliterated by the burning away of the carbons. When there is little or no burning away, as is the case with the Jandus lamp, we should expect to find this production of a point and a crater greatly accentuated, and in an exaggerated form. Nothing of the kind, however, happens; both the carbons remain practically flat, without point or crater. Perhaps we shall have to modify our previous conceptions in regard to this matter.

We have still to consider the distribution of the light over a considerable space of ground. You will say perhaps that the light diminishes according to the square of the distance. Yes; that is quite true of a white hot ball, like the sun, but it is very far from true of the light of the electric arc. The light emitted in one direction is very much greater than that in another direction, and it depends very much what that direction is. Mr. Hesketh, of Blackpool, has been experimenting, both with the Jandus lamp and with an arc lamp burning in air. Figs. 3 and 4 give his results in a graphic form. You will notice that an arc lamp, burning in air, shoots down its rays in such a way that the maximum is attained at an angle of 45° from the perpendicular, while the Jandus lamp attains its maximum at about 75°, that is to say, only 15° from the horizontal. Consequently, while the ordinary arc lamp

Fig. 4.



SCALE OF FEET. (HEIGHT OF POST - 20 FEET)

brilliantly illuminates objects almost immediately underneath it, and objects at a distance only slightly, the Jandus rays are better distributed over distant objects. Fig. 5 shows the amount of illumination on the ground at different distances. Assuming the lamps to be placed at a height of 20 ft., the ordinary arc lamp produces a prodigious illumination up to 20 ft. or thereabout, but then it rapidly falls off. At 34 ft. it is less than the light of the Jandus, and then it dies away almost to nothing. The Jandus, on the contrary, starts low, owing to the partial shadow of the lower carbon. As soon as we get out of the shadow of the corner of the lower carbon the light increases, and then, owing to the nearly horizontal direction of its maximum, it diffuses its light very equally, and, as you see, it illuminates objects at 140 ft. quite as much as the ordinary arc does at half that distance.

The advantages presented by the Jandus lamp may be summed up as follows:

It will burn on the public mains which have usually a voltage of about 110 without any accessories whatever.

The ordinary arc lamps must either be placed in series or must be furnished with a comparatively high resistance, so as to reduce the voltage to about 40. This means conversion of a good deal of electricity into heat which does nothing but keep the wire of the resistance warm.

The lamp is very economical, the consumption of carbon being insignificant.

The distribution of light is very equable, far more so than in the case of the ordinary arc lamp.

The construction of the lamp is extremely robust. There is no clockwork or delicate mechanism. Probably it might fall from a considerable height without sustaining any other injury than the smashing of the glass.

It is eminently suited for illumination of chemical and other works. It is an essential part of the construction of the lamp that it should be practically air-tight. The working parts, therefore, would not be liable to be injured by gases or dust flying about in the factory.

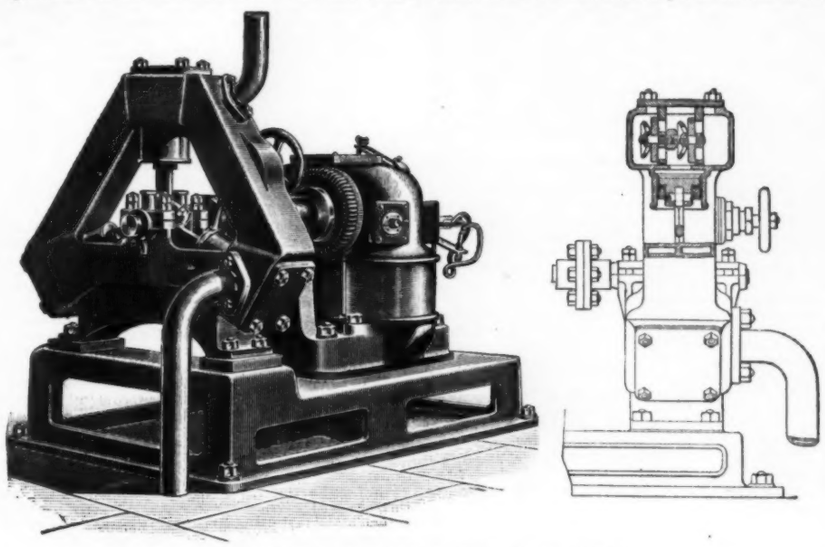
HIGH SPEED ELECTRIC MULTIPLE PUMP.

THE multiple pump represented in the accompanying engravings is of a new type, particularly adapted for use in country houses lighted by electricity. It is absolutely noiseless in its operation, and is capable, not only of being used for raising water to the reservoirs that supply the piping, but may also be provided with an arrangement to permit of accelerating the speed so as to increase the discharge at a high pressure in case of fire.

As may be seen, three pump chambers are arranged symmetrically with respect to the central shaft, which, ordinarily, is coupled directly with the electric motor. These three pump chambers, as well as the valve boxes and the channels for the circulation of water, are cast in a single piece with the triangular frame. Their diameter is relatively great with respect to stroke, which is short. It is thus possible to cause the pistons to operate at a high speed. The pump figured makes 700 revolutions a minute.

The clacks, which are of India rubber, are of special form—one that has already been adopted by the firm for its fire engines. They uncover a wide aperture with a relatively small ascent. In order to facilitate the starting of the electric motor, there is placed between the force and suction channels formed in the frame a by-pass valve cock, through the opening of which the charge upon the motor is rendered very feeble, so that it may be set in motion without giving rise to sparks.

These pumps are constructed in two series, one of which comprises those that are capable of running at two speeds for water and fire service and the other



HIGH SPEED ELECTRIC MULTIPLE PUMP.

those that run at a speed not exceeding 200 revolutions. The following are a few data in regard to these types:

FIRST SERIES.

Water per minute at 200 revolutions,	45, 68, 113, 180
" " " " 600 "	127, 180, 318, 520

SECOND SERIES.

Water per minute at 200 revolutions,	136, 200, 340, 545

The two small models of each of these series are constructed entirely of gun metal, except the frame, which is of cast iron. It is unnecessary to say that any sort of transmission may be used with these pumps, which, aside from the advantage that they possess of operating noiselessly, are remarkable for the constancy of their discharge and the small amount of space that they occupy.—Revue Industrielle.

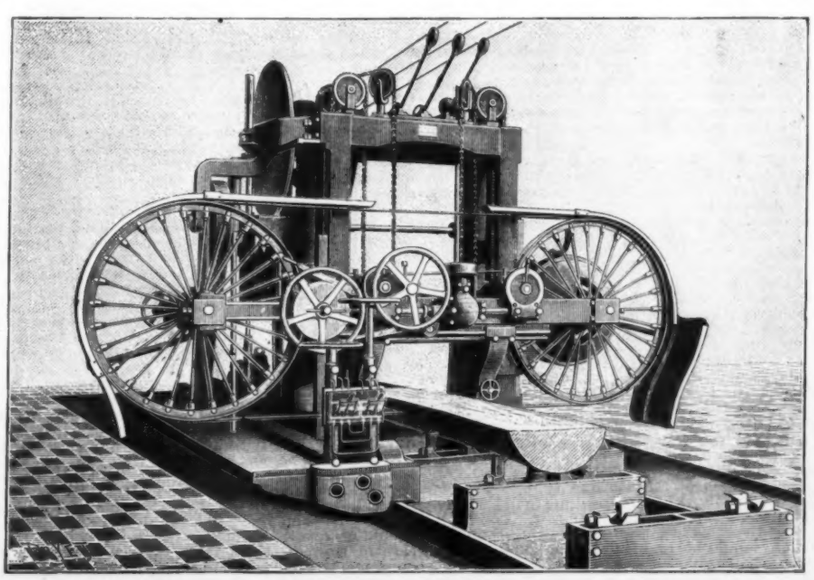
AN ELECTRIC BAND SAW.

NOWADAYS, when it is a question of machines of a certain power, and that have to produce a large amount of work, an endeavor is made to run them electrically. We have already mentioned a large number of installations of machine tools of this kind, such as windlasses, cranes, lathes, drilling machines, etc., and now purpose making known a horizontal band saw driven electrically, and manufactured by the Société des Machines d'Oerlikon, in Switzerland.

This new machine consists of a bottom frame upon which rest rails and cross pieces designed to hold in position the trunk of the tree to be cut. By reason of the stability of the parts, boards of an absolutely equal thickness are obtained. The two pulleys that carry the blade of the saw are seen in front. Upon one of these pulleys, the one to the right, is placed a 16 h. p. electric motor. These two pulleys, along with the blade of the saw, can be easily raised by the simple motion of a lever and be lowered by means of a hand wheel, according to the thickness that it is desired to give the boards. In front of the apparatus, to the left, may be seen the interrupters. The velocity of the saw reaches about 38 meters a second.

The saw has likewise to move forward with great speed in advancing into the wood. The minimum value of such speed is 11 meters a minute. This motion is obtained through a 6 h. p. electric motor. This saw is capable of performing a large amount of work. In fact, it is easy to place a series of trees in its track so as to have it cut them in passing.

This machine tool has already been utilized in several installations, where it has rendered great services in doing the work of several laborers in a day.—La Nature.



AN ELECTRIC BAND SAW.

THE USE OF TELEPHONES BY ROYALTY.

AN unaccredited item in one of the daily papers gives the following information, which is alleged to be correct, about the use of the telephone by the "crowned heads of Europe."

Now that Queen Victoria has at length permitted the installation of the telephone at Windsor Castle, Osborne House, Balmoral and Buckingham Palace, there is not a sovereign in Europe who does not utilize this instrument for communicating royal and imperial wishes, as well as commands to subjects and officials. Even the Pope, who has decided that, while a confession may be heard over the telephone, the priest cannot use the wire for the purpose of granting absolution, has had a receiver installed in his private apartments by means of which he often communicates with the Propaganda Fide, which is situated on the other side of the Tiber and at a considerable distance from the Vatican. It is generally his valet, Cintra, who does talking over the wire for him, but he occasionally speaks over it himself, and only the other day, when a Jesuit priest was taken suddenly ill during a private audience, the Pope rushed to the little red-lined booth and personally called up the Jesuit college, says an exchange.

King Leopold is enabled by means of the telephone

to communicate with his ministers at Brussels without leaving his palace at Laeken or his marine residence at Ostend. When, a year ago, the little King of Spain was prostrated with the measles, and secluded at one end of the huge palace at Madrid, the Queen Regent was able to hold intercourse with him, located in a distant wing of the edifice, not only daily, but almost hourly, over the wire.

Queen Victoria, however, is so ultraconservative that it is most difficult to get her consent to any modern innovation, and it was only two years ago she permitted the installation of electric light in the state apartments of Windsor. Previously electricity, as well as gas, had been uncompromisingly barred from her private apartment. Yet it is almost impossible to exaggerate the importance of thus placing the various residences of the Queen in telephonic communication with London, as far as the transmission of official business is concerned.

Until now, whenever the Queen was desirous of consulting one of her constitutional advisers upon any point or when any cabinet minister had some matter of urgency to impart to Her Majesty, the unfortunate dignitary had to travel all the way from Windsor to Balmoral—a twenty-four hours' journey—or to Osborne, which entailed a sea trip across the stormy Solent, very often only for the sake of ten minutes' talk with the sovereign. Then, too, Lord Salisbury and even Mr. Chamberlain, both of them busy men, have had to spend a good deal of their time explaining matters to the Queen in writing.

In the same proportion that the Queen is old-fashioned in her views, in her surroundings, in her manner, and in her appearance, so is the Prince of Wales up-to-date. Marlborough House and Sandringham are fitted up with telephones and electric lights, in the most approved style. Should the prince survive his mother, his advent to the throne is likely to be marked by all sorts of innovations, which will have the effect of simplifying the present intricate manner of conducting the business of state.

In this respect he resembles his nephew, Emperor William II, of Germany, whose predilection for the telephone is a source of disgust to the various government officials at Berlin. There are instruments in his library and working room.

Although it may flatter the pride of the telephone people at Berlin to have the Emperor among the subscribers of the system, yet he gives them far more trouble than any other subscriber. For when he telephones to any of the government departments, the operators at the central office are under the strictest orders to abstain from listening to the conversation.

THE TESTING OF INDIA RUBBER GOODS.

We have on more than one occasion been approached by buyers of India rubber goods with queries as to some method of ascertaining the quality, even approximately, of their purchases. Something besides chemical analysis is wanted, they say, as such analyses are not only apt to be expensive, but in many cases they do not indicate the presence of any latent evil, such as errors in mixing the materials or in vulcanization. Such faulty workmanship is apt, when the goods are in use, to show itself in an undesirable way, and consequently to lead to passages of arms between buyer and seller, a condition of things to be avoided in the interests of both parties. It is the wholesale buyer who more often finds himself in difficulties in this way, because, although he can generally by strong representation get the goods complained of replaced by the manufacturer, yet such replacement does not obliterate the effects of the evil, as loss of trade resulting from a bad name is not regained all at once. Another great drawback to chemical analysis is that the goods have to be cut up, or, at any rate, cut into, at some point or other to obtain material for the analyst to work upon, and in many cases it means a serious loss to do this. Again, the cutting up of one article of comparatively small value does not conclusively show that the figures obtained from its analysis apply to the whole delivery of which it is a unit, such is the variation that is so commonly found in deliveries of rubber goods. Thus chemical analysis, on the whole, seems out of the question, and it therefore remains to be seen how far physical tests can be adapted so as to give a fair criterion of the quality of the goods and of their suitability for the purposes for which they are intended, while at the same time no damage is done to the articles by the test so as to unfit them for sale. To mention some specific cases, It may or may not be matter of common knowledge that the majority of our leading railway companies submit all deliveries of carriage and wagon buffers to severe mechanical tests, and such as fail to reach a certain standard are rejected. It should be mentioned that such tests are only insisted on by those companies who pay a fair price, and expect to get sound rubber.

At the present time there are great variations in the prices paid by railway companies for goods intended for the same purpose, three times as much being paid in some cases as in others. We doubt the policy of buying cheap and nasty mechanical rubber, but in the light of what has occurred in other branches of the rubber trade, it is gratifying to find that the railway companies who buy such goods do not expressly stipulate that they shall stand the tests usually applied to the best quality. This testing of buffers on a large scale of course takes time, and involves, in addition, the purchase of rather expensive machinery; but there is no doubt that it pays the buyer. Without going into great detail, it may be said that the buffer testing machine is on the principle of the ore stamp, five or six hammers being worked by a cranked axle, and striking blows on as many buffers. The superficial dimensions of the buffer springs are carefully measured before and after the test, which may consist of from 1,000 to 10,000 blows, and may last a whole day. A good buffer should measure the same after as before the test, though one of inferior quality, i. e., wanting in elasticity or badly vulcanized, will be found to have sustained a permanent set after the test. It will be seen at once that this test is of more value than any chemical one would be, and it puts the rubber manufacturer on his mettle, as it is no easy task to get such an equality of vulcanization as is required to conform to the standard of this test. We have known of cases where half a delivery has been returned as unsuitable, though to the best of the rubber manufacturer's knowledge the material and the method of manufacture was similar throughout. We rather suspect that variations occur in the rubber which are not to be detected unless by some such severe test as the one under notice, and which could hardly be discovered in the unvulcanized rubber, though this is a technical matter which does not directly concern us at the present moment. It is necessary to add, however, that, whether owing to this inequality in the elasticity or lasting power of rubber buffers, or to other causes, there seems to be a decided revulsion of feeling in favor of steel springs for rolling stock at the present time, and it behooves the rubber manufacturers to look to their guns unless they wish to lose a considerable business. We append here some figures obtained by a railway company from a delivery of buffers all supposed to be of equal quality, and they show decidedly that some variation either in the quality of the rubber or in the method of manufacture has occurred:

	Loss after Plates. Per cent.	Loss after 10,000 Machine Blows. Per cent.
1	nil	50
2	"	39
3	"	19
4	"	25
5	"	10
1	2	48
2	8	43
3	17	36
4	7	45

The loss after plates, it should be said, refers to the permanent decrease in thickness noticed after the buffers have been screwed up under pressure for a length of time between iron plates, and the percentage of loss refers to the decrease in lifting power or elasticity. For example, a buffer which will lift a weight of 6 tons before undergoing the machine blows and only 3 tons afterward shows a loss of 50 per cent. It is rather exceptional for a delivery of buffers to show such great variations as are given in the table, but the figures show the value of the test from the railway engineer's point of view. Other railway goods, such as vacuum diaphragms, hot water hose, etc., cannot be so easily tested, though a system of testing high pressure steam tubing by attaching two or three lengths to steam jets, and comparing their behavior under pressure, has been adopted with good results, as indicating the temperature and pressure the hose is capable of standing without injury. Leaving the railway companies, we may glance at some points in the specifications sent out by the Admiralty, who are large buyers of rubber goods, and for whose contracts there is considerable competition. The rubber has to be supplied in the form of vulcanized sheets, and it is cut into valves, washers, etc., as required at the various dockyards. Three qualities of rubber are bought, and the exact amount of rubber, mineral and sulphur they are to contain is specified, any variation from the figures given rendering the contractor liable to have the goods thrown back on his hands, a contingency which it is unnecessary to say involves him in considerable loss. The testing employed seems to be almost entirely chemical, and the strictness with which the authorities visit any variation from the limits of sulphur laid down in the specification is carried to a degree which we venture to say is hardly warranted. The idea of a low limit of sulphur is, we suppose, that the goods are less liable to deteriorate when in use by reason of oxidation of uncombined sulphur; but it must not be overlooked that a low content of sulphur necessitates a prolonged vulcanization, and it is extremely doubtful, to say the least of it, whether this prolonged heating is better for the rubber than would be the presence of say an extra one-half per cent. of sulphur, which would tend to shorten the time of vulcanizing.

Some few years ago Lieutenant Vladimiroff, of the Russian navy, made a series of experiments to establish the testing of rubber goods on a sound and satisfactory basis, the following being the main conclusions at which he arrived. It will be seen that the tests advocated are physical ones, as he came to the conclusion that chemical testing gave no reliable results.

1. India rubber should not give the slightest sign of superficial cracks on being bent to an angle of 180° after five hours' exposure in a closed air bath to a temperature of 125° C. The test pieces should be about 6 centimeters thick.

2. Rubber containing not more than 50 per cent. by weight of metallic oxides should stretch to five times its length without breaking.

3. Pure caoutchouc free from all foreign matter, except the sulphur necessary for its vulcanization, should stretch seven times its length without breaking.

4. The extension measured immediately after rupture should not exceed 12 per cent. of the original length of the test piece. The test pieces should be from 3 to 12 millimeters wide and not more than 6 millimeters thick and 3 centimeters long.

5. The percentage of ash gives a certain indication of the degree of softness, and may form a basis for the choice between different qualities for certain purposes.

Any excess of sulphur over that required for vulcanization should be removed at the works, and should not appear on the surface of any object.

Now these tests on the whole seem very well calculated to give useful indication to engineers as to the quality of the goods they are buying, only we would interpolate here the remark that unless a good price is paid for the rubber, it is no use submitting it to such physical tests as these. India rubber substitutes made from oil, and "recovered rubbers," i. e., old rubber worked up again with oil, have nothing like the elasticity appertaining to new sound rubber, and they are quite incapable of standing the elongation or heat tests mentioned. The concluding remark of the lieutenant is somewhat naive, and though no doubt it expresses a desirable consummation, we may perhaps be permitted to ask how it is to be effected. No doubt the excess of sulphur over and above that required for vulcanization should be removed, but how is it to be done? In the case of thin goods, consisting of rubber and sulphur only, it is possible and, indeed, is the regular practice, to remove the excess of sulphur by boiling in a solution of caustic soda, but this could not be done in the case of valves or buffers over an inch thick. Of course the alternative to this is the English Admiralty low limit of sulphur, but, as we have already said, we are not particularly enamored of this, and do not feel inclined to recommend its more general inclusion in rubber specifications.

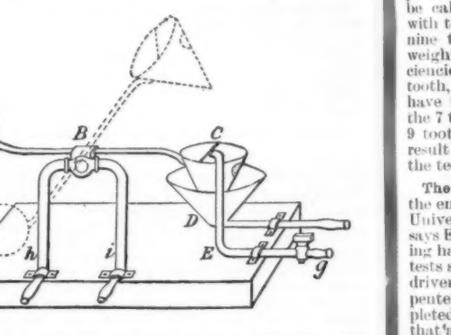
The specific gravity of a rubber compound, or what comes to the same thing, the number of cubic inches to the pound, is very generally taken by buyers as a correct index of the value, though in reality such is often very far from being the case. In the rubber works the qualities of the rubber made vary from floating, the best quality, to densities corresponding to 11 or 12 cubic inches to the pound, the latter densities being in demand nowadays by many consumers with whom price appears to be the main consideration. It will be obvious that such densities as these can only be obtained by utilizing to the utmost the quality that rubber exhibits of taking up a large bulk of added matters.

In Lancashire a common test of mechanical rubber is to throw it into the millpond to ascertain its floating power or otherwise. Of course it is all right as discriminating between a floating and a compounded rubber, but the mere fact of a rubber floating does not show that it is necessarily of a good or elastic quality, because it must be remembered that there may be a large amount of extraneous organic matters present in the form of oil substitutes which are of practically the same density as rubber. By such a test a compound containing a considerable quantity of substitute is found superior to one consisting of the best rubber and 20 per cent. of zinc oxide, a conclusion which would not by any means be borne out in practice. We therefore hold out a word of warning to buyers of rubber goods not to set too much store by this gravity test, as it may very often afford an incorrect criterion of value, though at the same time it is difficult to suggest an alternative test of equal simplicity, or one that does so little damage to the goods. It is, of course, apparent that rubber containing 10 or 70 per cent. of mineral will sink equally in water, and it is useful to extend the test by employing solutions of common salt or chloride of calcium which a rubber of approved density will float in, and samples can be compared with this as a standard at any time. Space prevents our going further into this matter of rubber testing, and we shall conclude with the observation that on the whole what the Russian authority says about the inadequacy of chemical analysis is well founded, and it behooves engineers to work out special mechanical tests easy of application which may serve to convince them that what they are buying is—to use a borrowed expression—of the nature, substance and quality demanded.—Engineering.

AUTOMATIC GAS TAP.

By H. Michaelis.

To obviate the inconvenience and risk liable to occur when working with constant level water baths or with



Liebig condensers, through failure of the water supply, the author has devised the following gas tap, which closes automatically when the water current, through any cause, ceases.

The apparatus is connected with both the gas and water supply, and its construction is shown in the accompanying figure.

The gas flows through the tubes, h, i, so long as the lever attached to the tap, B, remains horizontal. This lever carries at one end a weight, A, and at the other a funnel, C. The tube, E, is connected with the water supply, the tap being at g, and through it water flows into the funnel, C, running away partly through a small opening at the apex of the funnel and partly through an overflow opening somewhat below the funnel rim, into the larger funnel, D. So long as the funnel, C, is filled with water—i. e., so long as the water feed continues—it balances the equal weight, A, and the tap remains open. Should the water supply cease, the water in C runs gradually away through the small apical opening, and the weight, A, then bears the lever down until it takes up the position shown by the dotted lines, in which the tap is closed.

The water supply to the funnel, C, may be the overflow from the water bath or condenser. The water must, naturally, be fed into C more quickly than the lower opening in the funnel will allow it to flow into D.

There is also a small hook, not shown in the figure, to hold the lever horizontal, should it be desired to use the burner alone and without the water supply.—From the Berichte in the Journal of the Society of Chemical Industry.

Some tests recently made on molybdenum steel by Prof. W. Von Lipin, of St. Petersburg, show that molybdenum steel resembles wolframium steel in a general way, although it is less affected by annealing and tempering. Annealing makes it softer than wolframium steel; high heating, on the other hand, makes it harder than the latter. This steel can stand treatment in the fire as well as tempering better than wolframium steel, and shows no fissures where wolframium steel very often does. This may be the cause for the numerous attempts to substitute molybdenum for wolframium, and especially chromo-wolframium steel.

ENGINEERING NOTES.

The traffic on the London Metropolitan and Metropolitan District railways for the first half of 1897 amounted to 69,260,675 passengers, says Engineering News. At this rate the total traffic for 1897 would be 138,521,350. In 1896 the actual number of passengers carried was 131,131,305, as compared with 121,163,803 in 1886 and 76,388,417 in 1876. The Metropolitan Railway is a little over 69 miles long, and the Metropolitan District operates about 14¾ miles. The length of line worked by the engines of the first named company is 80¼ miles and that of the second is about 36 miles. During the first half of 1897 the aggregate train mileage of the Metropolitan was 1,441,152 miles and that of the Metropolitan District was 765,426 miles. The one company on July 1, 1897, owned 80 locomotives, 406 passenger cars and 242 freight trucks, and the other company owned 54 locomotives, 374 passenger cars and 35 freight cars. The capital expended by the Metropolitan Railway to July 1, 1897, was $61,323,765, while the Metropolitan District had expended to the same time $38,681,065. The net revenue from the first named line for the first half of 1897 was $1,174,260 and that of the Metropolitan District was $627,740.

A curious accident took place in France lately, says The American Architect. On the third of July, an inundation of the River Adour carried away a stone railway bridge at Tarbes. It happens that General Marcille, of the engineer corps of the French army, has devised a form of steel bridge for military purposes, which can be transported in sections, and quickly erected in place; and the railway company applied to the military authorities for a bridge on this system, to serve temporarily, until the stone bridge could be rebuilt. Several of the Marcille bridges have already been successfully used, and sections are kept ready at the army stores, so that on July 17, two weeks after the accident, the new bridge had the rails laid over it, and was ready for testing. The test was made by running a testing train, consisting of two locomotives, with their tenders, and two loaded freight cars, on the bridge. Hardly had the train advanced fairly upon the bridge, running very slowly, when the box girder, of which the bridge substantially consisted, began to twist in the middle, and gave way, throwing the train into the river. Several men on the train were injured, but, fortunately, no one was killed.

There is a strong tendency among bicycle makers in pandering to the public taste for lightness of parts to reduce the size of the sprocket wheel on the rear axle. That this is a mistake is proved by an experiment recently made to determine the comparative efficiency of sprockets of different sizes. To carry out the experiment the bicycle was inverted, and the frame securely attached to the floor. A thin steel band had one end attached to the tire, and the other end carrying a weight which was raised by the band being wound upon the tire, a second weight being hung from a scale pan attached to the pedal, whence the efficiency of the portion of the mechanism transmitting the power could be calculated. A long series of readings were taken with the same large sprocket and with seven, eight and nine toothed sprockets on the rear, and with pedal weights varying from 2 lb. to 50 lb. The average efficiencies in each case were as follows: 7 tooth, 89·9; 8 tooth, 91·5; 9 tooth, 93·4. This shows the 8 tooth to have 98·9 per cent. of the efficiency of the 9 tooth and the 7 tooth to have 96 per cent. of the efficiency of the 9 tooth sprocket, other conditions being equal. The result proves that there is less chain pressure upon the teeth of the larger wheels, and hence less wear.

The friction of bicycle chains is being investigated in the engineering laboratories of Sibley College, Cornell University, under the direction of Prof. R. C. Carpenter, says Engineering News. The question of chainless gearing has also received some attention. The results of the tests so far made are unfavorable to all forms of wheels driven by other means than the usual chain. Prof. Carpenter says: "Our investigations are not entirely completed at the present time, but it seems safe to announce that all the tests indicate that no form of gearing can possibly equal the best chain for efficiency and durability." As a result of tests of chains which had been in actual and severe use, it was found that friction varied from 2 to 5 per cent., depending upon the construction and previous use. The highest friction found was 10 per cent., in the case of an old chain which did not fit the sprocket. The friction of a complete wheel was tested under working conditions in several instances and found to vary from 5 to 40 per cent. of the power applied. For high grade wheels this value ranged between 5 and 8 per cent. In all the tests of bevel gears and geared bicycles the chain gear was found more efficient than the other forms. Another feature adding to the success of the chain in competition with chainless wheels is that the friction remains practically constant at all loads, while with the geared wheel the friction is greatest when the load is greatest.

Milwaukee's use of its fire boats for fighting fire at a distance from the river front is attracting attention in other cities with navigable waters. Cleveland, Detroit and Buffalo have adopted the system, and Boston is preparing to do something with it. In Milwaukee the idea was born of necessity, the first suggestion being for a pipe line from the river to an isolated manufactory in a section where the water mains had not penetrated. The pipe was laid, and the first test with a fire boat at the river end showed a complete success. Since then lines have been laid to cover a great part of the business district of the city. They extend in some instances even as far as 3,000 feet from the river on either side, and have been proved to be effective even with an elevation of 86 feet, and the consequent large back pressure. The chief of the fire department says that a fire boat at the end of a pipe line is worth from three to six engines, according to the length of the line. Therefore, by the extension of the lines at a comparatively small cost, the city has been saved the expense of several engines, to say nothing of the engine houses and the keeping up of companies. The piping costs but little more than the same length of hose, and when laid is practically indestructible. In time at least one-half of Milwaukee will be protected in this manner—a protection more efficient than that provided by fire engines and obtained, moreover, at a minimum of cost.—New York Evening Post.

ELECTRICAL NOTES.

The material most commonly used for the cores of electromagnets is soft iron, on account of its high permeability. But soft Martin steel is often quite as effective and is more easily obtained. It may be used wherever a rapid change of magnetization is not essential. A comparison, undertaken by A. Abt, between two exactly similar horseshoe cores weighing 47 kilogrammes of soft steel and soft iron respectively, gave 0·98 to 1·04 for the ratio of the permeabilities of the former to the latter, and 1·2 to 1·3 as the ratio of the permanent magnetisms. This places soft steel very close to soft iron in magnetic behavior. Cores of steel have the additional advantage over iron of greaty tenacity.—Abt, Wied. Ann., No. 8, 1897.

The Plunger, a submarine torpedo boat of the Holland type, designed for the United States navy, was successfully launched at the yards of the Columbia Iron Works, Baltimore, on August 7. The boat is cigar-shaped, eighty-five feet in length and eleven feet five inches in diameter. When floating light, it had a displacement of one hundred and fifty-five tons, and when down to the load line, one hundred and sixty-seven tons. A steam plant is provided to operate twin screws when afloat or awash, and a seventy horse power motor, furnished with current from forty-eight storage batteries, will operate the vessel when submerged. The steam power, electric dynamo and storage cells are so arranged as to be readily reversed, thus making it possible to recharge the cells from the power plant on the boat. The electric power may also be connected to the propeller shaft placed in the axis of the boat, in addition to the connection with the main propeller shaft. The motor may thus operate a special propeller in addition to driving the main shaft independently of the steam engines.

The Street Railway Journal says: "We notice that the Electrical Review, of London, takes exception to the statement of President Clark, of the New York, New Haven & Hartford Railroad, that cars have been operated for hours over sections of his line when both the third rail and service rails were covered with water. The Review evidently thinks that such a thing is impossible and 'a piece of exaggeration that any tyro would detect.' It is true, nevertheless, that such things have happened and can happen, and, in fact, may be expected to happen under such conditions as are found at Nantasket Beach, for it is a fact demonstrated repeatedly in conduit and third rail work that the resistance of rainwater or even of water which is by no means chemically pure is sufficiently great to prevent a leakage approaching a short circuit on a line with only five hundred volts pressure. Those who have tested railway plants with water rheostats can easily understand this, knowing the difficulty of forcing a large volume of current through a body of water, unless the plates are placed quite close together; and we may add for the benefit of our doubting contemporary that the recent heavy rains in Connecticut flooded the tracks of the Hartford-Berlin third rail electric road without interfering with operation."

A portable motor and drill, with magnet, for use in iron and steel plants, where heavy castings and forged pieces must be transferred from one department of an establishment to another, is described by Dr. Louis Bell in The Engineering Magazine. The motor is provided with a worm driver drill, together with a universal mounting of four adjustable feet. When placed fairly upon a ship's plate or other mass of iron, these drills have an adhesive force of nearly half a ton each. The drill can be adjusted and clamped by the simple turning of a key, and it will bore holes up to an inch in diameter as fast as it can be safely worked. The whole affair is of only about two hundred pounds weight. Another convenient application of this principle is reported as in use at the works of the Illinois Steel Company. In the rolling of boiler plates, the resulting sheets, twenty or more feet long and weighing from a quarter to half a ton, are, of course, difficult to handle, and, when to be moved, are objects very difficult or inconvenient to sling. To meet this difficulty, a pair of powerful electromagnets were rigged up and attached to the traveling crane, so that all that is now required is to drop these magnets down upon one of the long plates, which is thus held at two convenient points, and to send it rapidly down the room, dropping it into place without a jar.

The Canadian government has submitted formal proposals to this government to establish communication with the Klondike region in Alaska by the construction of a telegraph line from the head of winter navigation on the Lynn Canal to the center of the Klondike region. The proposals have been taken under advisement, says the Electrical World. They have been approved by the British Principal Secretary of State for Foreign Affairs, and were forwarded by the Governor-General of Canada through the British Embassy to the State Department and referred to the Interior Department. The papers are locked up pending consideration. The proposals, while reserving the right of either country pending the settlement of the international boundary line between the United States and Canada, south of Mount St. Elias, urged the expediency of establishing a permanent route giving access to the interior at all seasons of the year. The most feasible route, according to the Canadian authorities, would be to start from the head of the navigation in the winter on the Lynn Canal (the body of water running from Juneau up beyond Dyea and Chilkat), forming part of the present overland route, crossing the mountains by White Pass or by any other pass which may seem more accessible, and proceed northward to Fort Selkirk and thence to Klondike. The Canadian government asserts its readiness to undertake to open communication by constructing a telegraph line from the head of winter navigation on the Lynn Canal, traversing a distance of eighty miles, across the summit of the mountain range to a convenient point northeast of the mountain range, from which a trail can be followed to Fort Selkirk and Klondike. The government also signifies its intention, in case the propositions are adopted, to erect suitable places for shelter at periods from forty to fifty miles along the line, and to keep up dog trains during the months of winter for the conveyance of the mails to and from the interior.

MISCELLANEOUS NOTES.

The old sumptuary laws of the middle ages are called to mind, says The Iron Age, by a singular decree which has recently been issued by the Bulgarian Ministry of Agriculture and Commerce, by virtue of which all the officials and functionaries of the state, of the towns and of the communes in that country, and even deputies when in session, are compelled to wear clothes and boots made in the country, of stuff or leather also produced in the country, under penalty of fine or other punishment. The cloth and leather in the piece must bear a certain mark, which mark must also be found in the made up article. Where the Bulgarian officials have ordered clothes and boots, they are obliged to retain an invoice as a proof, and when buying new clothes, must notify the official in control.

The introduction of a new oarlock for boats is recorded by the Chicago Tribune as involving an additional extension of the ball bearing system in minimizing friction. As described, the rowlocks in this case are of brass, with three point ball bearing, casehardened steel working parts; they are furnished in either polished brass or nickel plated, as may be desired. These materials will not bend or spread, and so the oars will move in them always the same, and thus there can be no liability to uneven rowing on account of the locks being of different shapes and angles, as is not infrequently the case with compositions of a softer character. The statement is made that this ball bearing rowlock affords an ease in rowing which is most remarkable.

The French manufacturers of asbestos goods are supplied from four sources, says the Engineering and Mining Journal: 1. Canada, whence the asbestos is white, silky, very unctuous, having supple fibers from 5 to 25 mm. in length; of all varieties it is that which spins the most easily. 2. Siberia, whence the mineral is yellowish, some species from the straw yellow. The fiber is less flexible than the Canadian, more woody and dry, but stronger. Their length is about the same as the Canadian, but large masses of long fiber mineral are rarer. 3. The Cape of Good Hope asbestos has a characteristic blue color. It comes in larger pieces than either the Canadian or Russian, and their fiber is generally longer and stronger. In spinning or other manipulation, however, it is difficult to handle them, a good deal of the fiber being reduced to powder. 4. In Italy there are different kinds of asbestos, but generally they are little adapted to spinning. There are some long silky fibers of little resistance employed for gas furnaces, and others which are very short and fit only to make heat-retaining coverings.

For ages the English and French controlled the manufacture of hair pins, and it is only within the last twenty years that the goods have been produced in other countries to any extent. The machinery used is of a delicate and intricate character, as the price at which the pins are sold necessitates the cheapest and most rapid process, which can only be secured by automatic machines. The wire is made expressly for the purpose and put up in large coils, which are placed in a clamp and so carried to the machine while being straightened. This machine cuts, bends, and by a delicate instantaneous process sharpens the point. Running at full speed, it will turn out 120 hair pins every minute. To economize, it is necessary to keep the engine going day and night. The difficult part of the work is in the enameling, which is done by dipping the pins in a preparation and baking in an oven. It is here that the most constant and careful attention is required, as the pins must be absolutely smooth and the enamel have a perfect polish. The slightest particle of dust causes imperfections and roughness.—Pearson's Weekly.

The British Liquor Licensing Laws Commission has just issued a report that contains some interesting information about temperance drinks, a subject that might properly interest the United States Treasury Department, not to say American temperance societies. What is called "herb beer" was found to contain 11 per cent. alcohol, a warranted "blue ribbon" drink contained 8 per cent., "parsnip beer" contained 14 per cent., which is more than the beer usually sold in the saloons contains, and even more than that was found in "horehound beer," "bicycling tonic" and "temperance beer." Ginger beer, a favorite temperance beverage, was found to contain from 5¼ to 8¼ per cent. of proof spirit. "And," remarks a British newspaper, in commenting upon the discoveries of the commissioners, "not merely the drinks, but the sweets which more or less innocent children are in the habit of consuming in larger quantities than is good for them, are, alas! not free from alcohol." It is just possible that a great many total abstainers will not thank us for mentioning the alcoholism of drinks hitherto believed to be free from that article. In England the laws allow a 2 per cent. alcoholic beer to be sold without a license.

Almost all the bristles used in this country in the manufacture of brushes are imported, and notwithstanding the increased production of pork in this country, the supply of American bristles is now even smaller than it formerly was. Hogs are fattened and killed young in this country, and with the constant and widespread improvement of the breeds here, the hogs have run less to bristles. Some extensive packers collect bristles, but the American supply is probably less than 1 per cent of the consumption. The longest American bristles are about four and a half inches in length. Imported bristles come from various parts of Russia, but most largely from Poland and North Germany. Some finer soft bristles come from France. The bulk of the supply comes from cold countries, where the hogs are well protected by thick coats, and many of the bristles are those of wild hogs. The hogs shed their coats as many other animals do, and there are men who gather the bristles of wild hogs, knowing their haunts and where the bristles are to be found. Other bristles are collected in the usual manner when the hogs are killed. The bristles are subjected to various processes of curing and preparation before they become commercial bristles and ready for the market. Imported bristles range from three and a half to seven and a half inches in length. Various vegetable fibers are now used extensively in the manufacture of cheaper brushes, but for many uses bristles are indispensable and their importation continues steady.

THE NEW CATHEDRAL IN BERLIN, GERMANY.

Since the time of Frederick William IV. of Prussia it has been the desire of the monarchs residing in Berlin to erect a new cathedral for their use on the site of the old church built in the reign of Frederick the Great. On two occasions plans had been completely drawn up, but neither of them came to execution. Now, at last, two and a half million dollars have been granted toward the realization of the present Emperor's desire to accomplish what his fathers were prevented from doing. Professor J. C. Raschdorff and his son, Professor Otto Raschdorff, presented such a plan for the cathedral as was in proportion to the sum granted, and on June 17, 1894, the foundation stone was laid with great ceremony.

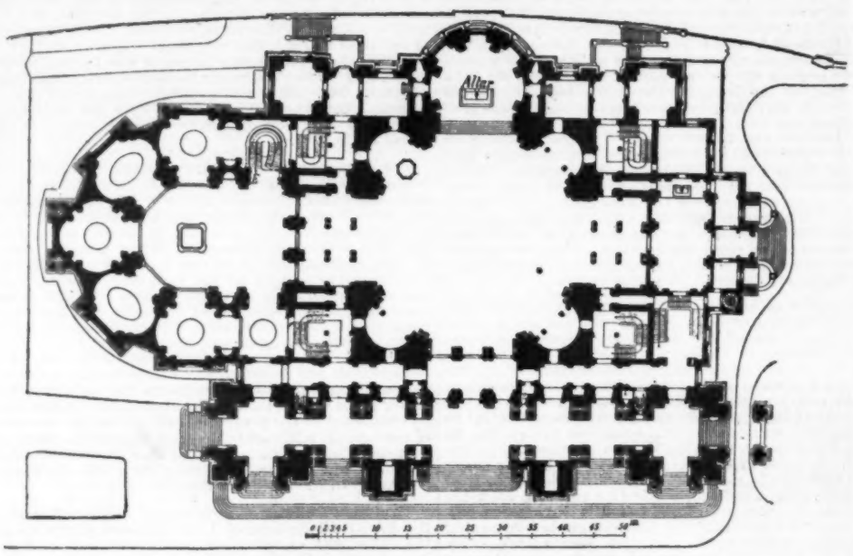
Our illustration, which we take from Ueber Land und Meer, shows the cathedral as it will appear when completed, looked at from the west, on the main façade. From the east façade there are steps leading down to the Spree River. To the royal castle, which lies on the right, the Kaiser Wilhelm's Brücke (Emperor William's bridge) and a street of the same name lead past fine cupola crowned houses, which also can be discerned on our illustration. On the left and right of the Lustgarten (the square in front of the west façade) stand the new museum and the National Gallery. Surrounded by grand buildings on all sides, the new cathedral will stand on one of the finest squares of the world.

We also reproduce from the same source as our illustration an elevation of the church. The longitudinal axis of this is 416 feet in length. In the center the main hall is built in form of a cross, of which the altar occupies the east arm; to the north arm (on the left) is attached the monumental chapel, itself surrounded by five elliptic chapels. Opposite, on the south, lies the chapel for marriage and baptism ceremonies. In the west a corridor runs parallel to the length of the building, connecting the various parts of the church, and leading at either end to a flight of stairs. In front of this corridor is the entrance hall, supported on a number of pillars, and opening with five doors on the steps leading to the Lustgarten.

The baptismal chapel will accommodate some 160 people; it is surmounted by a massive sandstone vaulting, and has a gallery for the choir. The main church has about 2,000 seats. The chancel is placed in the recess on the right of the altar, while the one laterally opposite contains the royal box. The north arm of the cross formed by this central hall is occupied by the organ and choir. High above the hall, 244 feet from the floor, a cupola 104 feet wide sheds its many colored light into the cathedral. A whole church with a good spire could be placed within this central hall. In the walls of the cylindrical structure which supports the cupola there are eight windows, each 32 feet high, which add their light to that given by the cupola. The walls are richly decorated with plastic ornaments. The monumental chapel is intended for the statues and memorials of the Hohenzollerns. The actual coffins are laid below in the vaults which extend under the church. The chapel is lit up by a large skylight in the vaulting, which is 61 feet wide. The walls of the small chapels around are of the most beautiful Mexican onyx, the columns are of red marble. From without the several halls can be distinguished by the appropriate shape of the exterior. Thus the cupola of the main hall rises high above the rest of the building, while on the left and right the baptismal and monumental chapels respectively raise their less pretentious cupolas. The central cupola is surrounded by four towers situated at the corners of the building, of which the front two are 210 feet high and hold the bells.

The entrance to the church is formed by a great arch, with fine columns on either side, over which is placed in a niche a figure of Christ, wrought in bronze, and over 16 feet high. At the same height, on the façade, are figures of the twelve apostles, and at the foot of the two pairs of great columns are grouped the four evangelists and the four great prophets of the Old Testament.

The cathedral is distinguished by its beautiful proportions, its simple grandeur, the perfect distribution and harmony of its mass; all this and the oneness of the building prove it to be the work of no mean artist. To the present time the church is complete up to the cornice. The great cupola has progressed to where the dome begins to spring. The iron frame of this cupola will be put up this year, and it is hoped that in two more years, for the Emperor's birthday in 1900, the whole cathedral will be ready for consecration.



PLAN OF THE NEW CATHEDRAL AT BERLIN.

THE NEW CATHEDRAL AT BERLIN, GERMANY, AS COMPLETED.

NEW GOBELINS TAPESTRY FOR THE EXPOSITION OF 1900.

THE author of this pleasing composition has fully succeeded in giving it the artistic character of the last century, and under the fingers of the skillful artists of the Gobelins the wool will render still better than color the luminous, chatoyant effects of the costumes of the period.

M. Claude has been able to obtain marvelous effects for the general harmony of his work from the pretty fashions of 1792. How far we are here from the monotony of the present costumes, especially on the masculine side! Here, the mayor himself is graceful and showy, with his white powdered wig, his clothing of black taffeta and his scarf worn over the shoulder, and not around the waist. The secretary is clad in apple green silk, and thus introduces a very lively note into the symphony.

As for the bride, she is absolutely ravishing with her hat "à la bergère" crowning a reddish flaxen head of hair. Her frock is of a light rose color, ornamented with all the furbelows of the fashion of the day.

The groom also presents a very fine appearance with his light blue coat, his amaranth knee breeches and his white silk stockings. The guests very harmoniously encircle the principal group.

At the Gobelins there has been taken up the very rational and eminently decorative method followed by the majority of the skillful tapestry workers of the last three centuries.

CIVIL MARRIAGE IN 1792—A NEW GOBELINS TAPESTRY.

The tapestries are surrounded by wide borders formed of most fanciful motifs—flowers and fruit, animals, arabesques, etc.

As the "Civil Marriage in 1792" is destined for the Salle des Mariages of the mayoralty house of Bordeaux, the arms of this illustrious city have been very cleverly introduced into the magnificent border.

The city of Bordeaux, as well known, bears the crescent in its coat of arms, not on account of Mussulman sympathies, but simply because of the form of its port. This is why three gracefully interlaced crescents figure at the four corners of the border, in addition to the coat of arms that occupies the center of the upper band.—Le Magasin Pittoresque.

The first ship having triple expansion engines to enter the transatlantic trade was the Martello, built in 1884 for the Wilson Line by Earle's Shipbuilding Company, of Hull. This ship was 370 ft. long, 43 ft. beam and 28 ft. deep. She had engines with cylinders 35 in., 50 in., and 89 in. in diameter and 57 in. stroke, carried 150 lb. working pressure, indicated 2,400 horse power and made 12 knots on a consumption of 38 tons of coal per day.

[Continued from SUPPLEMENT, No. 1134, page 18130.]

IMPROVIDENT CIVILIZATION.*

A PLEA FOR THE APPLICATION OF SCIENTIFIC METHODS TO THE AMELIORATION OF SOCIO-ECONOMIC DEFECTS AND DISORDERS.

By RICHARD T. COLBURN.

IV. SPENDTHRIFT LUXURY.

TRAVELERS in the Swedish-Norwegian peninsula concur in opinion as to the high general average of thrift and contentment existing, in spite of the uncongenial climate, the paucity of manufactures for export, and the presence of an aristocracy and a considerable standing army. The extremes of riches and poverty are not so great. What a pity that this Scandinavian secret of contentment cannot be made available in our more fortunate lands! True, there is a large consumption of ardent spirits, but the humid climate may account for it, or diminish in worse effects. Then the ratio of illegitimate births is high, but this is not to be charged to moral laxity of the women so much as to restraint laid upon the marriage of the young men by army and church. No very complete explanation of this Utopian satisfaction is offered beyond a pervading high literary standard due to excellent public schools; to a general and steady industry on the part of the whole population, male and female, young and old; and the absence of pretentious and ostentatious displays of wealth. The latter may be due to an anxiety to escape the tax gatherer; but it is refreshing to find one instance where the more liberal education coexists with industry and contentment, which it is fashionable in some countries to regard as incompatible. The same thing is true of Holland, which, however, lays the world under tribute by its floral tubers and Spice Island colonies; but Dutch thrift has made her a solvent creditor nation, and in time of stress she has but to sell her investments to draw from others. Other examples might be cited, Switzerland for one. The lesson to be deduced is the same, that industry, thrift, frugality, are the cure for hard times, for international competition, and contribute to good morals and stability of social order and progress.

Living, or rather working in the commercial metropolis of the continent, where is landed eighty per cent. in value of the importations of fabricated wares, I am continually impressed with the prodigality of our expenditures for things which have little, or only a transient, value. The loss of money, great as it is, is only the smaller part of the injury. It is at least debatable whether it would not be true economy, after having paid for the goods, to throw them all overboard in midatlantic—not at all on behalf of encouragement of home manufacture of similar articles, but to be rid of the pestiferous example and influence. These foreign articles not only keep the nation poor, but also debauch the public taste and conscience, set up false standards of what we can afford, introduce a succession of absurd fashions, and convert what should be stalwart men and women into mere fops and imitators. New York makes its living—a large share of it—in handling these importations, and distributing them widespread over the continent; and the greater its trade of this sort, the more the country is ruined. Its press, of course, from interest, if not from conviction, advocates the greatest freedom of trade, especially of so-called "objects of art," whereon the profits are so large as to leave a wide margin for advertising purposes.*

Consider for one moment what we get: a collection of millinery, bric-a-brac and finery which sooner or later finds its way to the attic or the rubbish heap; then reflect what we part with: the most precious part of our inheritance and labor, the phosphatic and nitrate constituents of the soil which do not quickly reproduce themselves like the ice taken from a lake, but are rather like the marble taken from the quarry. Deforestation may be followed at long intervals by reforestation, perhaps after damage by droughts and floods; the draughts on the fisheries (but not it would seem of the seal fisheries) may be made good by stocking, or by a close season; not so the soil, which must be replenished, or it soon ceases to repay the labor of tillage. Subsoil plowing cannot go on forever and adds to cost. The same cereals and breadstuffs we sell, at bare cost of production, the railroads are compelled to transport at a rate equal only to the train expenses, leaving the burden of interest on cost of construction to be borne by local or domestic traffic. The freight on a barrel of flour from points 1,000 to 1,500 miles inland to Liverpool is but a trifle more than to cart the same across any single city, and much less than to convert it into bread. Indeed, dealers have exhibited in Chicago loaves, made of Minneapolis flour, in Glasgow, of the same weight and cost as those produced at the lake port. It only remains to complete the reductio ad absurdum to reimport the Scotch bread in competition with the home-made article. This, however, is what we actually did for years with our cotton and wool fibers, sending them to Europe to be spun into thread and cloth, and would have continued to do so to this day if the arguments of the à priori economists could have prevailed. This is national improvidence; and its logical outcome is national dependence and national impoverishment.

By a provision of the Constitution, inserted at the instance of the more agricultural provinces, an export tax was forbidden to be levied. There has not been as yet much to regret in consequence; but one result is that any advantage which the United States may possess either in climate, soil, or beneath its soil, must be shared with other nations at the cost of extracting and transport. Our Canadian cousins are not so hampered, and are putting an export duty on logs and wood pulp. Russia and America have the great workable petroleum fields, without which the cost of illuminants would have been enhanced. How long these deposits will last is a matter of conjecture, and they are obviously more or less of a speculative investment. While free competition was possible, there was a general rush to empty them upon the glutted market at whatever the oil would bring. The State of Pennsylvania would have been justified in expropriating the entire territory and conserving the product for the benefit of another as well as the present generation. It might do so yet with advantage. The alternative was a combination of small owners into one great excusable monopoly. When this precious deposit is exhausted, we shall have the slender satisfaction of knowing we helped to light and warm the world at no profit to the owners, unless the upbuilding of one or two large estates is to be accounted a compensation. A like history is to follow our depleting reservoirs of natural gas. The same reasons apply pro tanto to the anthracite deposits in a very limited area; parts of five counties in the same State which, with the present ratios of increase, are liable to exhaustion in from 150 to 200 years. Anthracite coal will then be appreciated as a luxury.

We shall be told that it transcends the province of government to dictate what people shall like or dislike, or prescribe what they shall eat, drink, wear, or invest in; that the less it interferes with individual liberty, the better for society, and so on. Partisan as I am of the largest individualism consistent with the equal freedom of others, and the welfare of society, I am loath to appear as the spokesman of social invasion of personal preferences. Our duty to truth obliges us to face the facts; and there are apparently two sides to this question. The protest of Mr. Spencer and his school against such restraints is, however, a claim that one kind of want is as rational and legitimate as another, and is equally entitled to gratification. It is tantamount to saying one man has the natural right to tempt or inveigle another into buying anything he can palm off on him, and if carried to full length would not except minors, imbeciles or inebriates. We know, in fact, that the rule is not universal. The difficulty arises in running the boundaries between restraint and freedom; but daily life and administration of justice consist in drawing such distinctions. The gambler, the lottery dealer, and the pawnbroker desire nothing better than freedom; yet society does interfere with them. The underlying question for students is as to what tastes, cravings, instincts and aims contribute to the good of the race; which of them deserve to be encouraged, and which discouraged, by the state. On what other ground do all civilized nations tax spirits, tobacco and gaming implements?

In this matter of national or race prodigality, take a familiar illustration: The country boy who has been saving up his scanty hoard for a whole year to visit the

* An address before the Section of Social and Economic Science of the American Association for the Advancement of Science, August, 1897. Mr. Colburn is vice-president and chairman of this section.

* The assumption that in order to sell its own products, a nation must purchase a like amount from its customers is disproved every year by Brazil, which effects triangular exchanges; and by the United States, which liquidates its indebtedness by book credits, loans and disposals of shares and titles to property. Western Europe has been swapping its fancy articles and superfluities to a tremendous aggregate for evidences of our indebtedness, calling for annual interest and dividend payments and tourists spending money of over four hundred millions. Whenever Congress is disposed to curtail this waste and bring the income and outgo into equilibrium, a chorus of importers and foreign ministers goes up that we are in danger of tariff retaliation. Having brought their easygoing customer to the verge of bankruptcy, they demand as of right a continuance, and resent any attempt on his part to get out and keep out of debt as an affront to themselves. Retaliation may be left to correct itself.

county fair, or it may be a seaside resort, has no well defined idea as to what his purchases will be for the occasion, no list of demands to be supplied; but it is certain as fate that he will part with his cash for what new or striking thing he sees, it may be gingerbread, a coasting ride, or for street fakir's wares. It is just so with the whole national merchandising. At the bottom of every country merchant's list there is, in invisible ink, the further item: Any novelty or trinket in our line that we can sell. A demand such as this is created and supplied by the same act, and articles are being urged and foisted upon callow customers far beyond their natural desires, beyond their proper ability to buy, quite in the manner of heirs to large estates, dupes of crafty cheats.

These views have been forced upon the attention of economists rather than propagated by them. Homilies against riches as hindrances to post-mortem rewards are plentiful enough; but they do little to curb ostentatious or competitive displays. It is not, however, against the truly rich the charge of profligacy is aimed so much as against those who would be thought so; by the masses who entertain the notion that respectability is an affair of outside badges, lavish outlays and make-believe. Prodigality among the rich is responsible for much of this demoralization and apelike imitation. Country homes and city mansions are tolerable, even though for the most part their owners are not living in them but occupying the hotels of both continents. Yachts, racing stables, dog kennels, wine cellars, picture galleries, opera boxes, equipages, banquets, balls, costumes, jewels, are not the delights they are supposed to be by outsiders, but paraphernalia, the implements of a course of tiresome and exhausting exercises which society imposes on its votaries for no well-defined purpose, unless it be to excite the envy of those who cannot afford them, or, an elaborate system of match making and place hunting.

"Shall a man not do as he likes with his own?" is asked. That depends. Who does not know in the ranks of his acquaintance a proportion who, in good times and bad, by a generous table, or in showy hospitality, in dress or furnishings, devour the entire income week by week; people who might be comfortable but who never will be rich, nor yet acquire any competence for old age. The example of their neighbors and the multifarious temptations of the merchants are more than they can stand. Would you then destroy the inducements for acquiring wealth? Well, yes; some of them, at least. As already explained, I would encourage* self-denial and thrift on the part of rich, moderate and poor alike, until we as a people get out of debt to others; and after that to establish good roads, comfortable, sanitary homes and pleasure grounds; but not to enter upon a career of vanity and silly ostentation. I am glad to perceive in recent writers on economics a much clearer and firmer note than formerly on vicious luxury.*

V. THE BLIGHT OF PARASITISM.

Under Lycurgus, the pioneer social reformer, the Spartans held property in common. Satisfactory as the experiment was, it cannot be repeated, not even by imperial decree, without a supporting public opinion. To abolish individual property may not be possible now even by revolution, nor does it appear to be necessary or desirable, but some sort of restriction upon acquisition and transmission is desirable. "Can any man," ask the Socialists, "honestly accumulate so much as one million of dollars during his adult lifetime?" A slight acquaintance with either arithmetic or the investment of money at compound interest, or in the profits of trade, or agriculture, or pasturage, will show that he can. The familiar example of the blacksmith, who was to receive for shoeing the horse a penny for the first nail, two for the second, and so on, doubling for the whole series of 32, with a progressive doubling—not a remarkable increase for farmer, trader or stockraiser in each year—proves that he may become the owner of many millions, provided the rate of increase could be kept up for, say, a fifty-year period. The fructifying power of seeds and plants, or of domestic animals, forms the basis of about all the wealth of men and nations, that from mines, quarries and fisheries being inconsiderable. To a man not in either pursuit, it is practicable, as I personally knew a teacher to do, to lay aside one dollar per day between twenty and seventy, investing in good mortgages (formerly yielding seven and six per cent.) and the total is surprising to one who has not made the calculation, every dollar of it lawfully and honestly earned. The clamor against millionaires as such, which disgraces much of our social science literature, to say the least, is out of place. The more of them, the better—unless it can be shown that they have engrossed what belonged to others; or their use and disposition in some way contravenes the general welfare. It ought to be added that the rates of interest now being lower, five and four instead of seven and six per cent., and the profits from merchandising, farming, grazing and many forms of manufactures and transportation being halved and quartered by the competition of the larger surviving concerns, the chances of becoming a half millionaire by mere saving, without resort to speculation or usurious rates of interest, are much more remote.

Suppose we take, instead, the case of a person—it may be a bright, capable young man, a young woman, or even an imbecile ward, under guardianship—who inherits so moderate a sum as $40,000 during infancy, who, if he is fortunate enough to have guardians of judgment and probity—such a one may unknowingly become a millionaire without labor or economy. If one were able to add to this store further savings, and escape severe losses, the fortune might become very large, without encroaching on the rights of borrowers or lenders.

It is an interesting inquiry raised of late by the movement in favor of taxing inheritances now sweeping from one State to another, whether such an inheritance is honestly obtained, or if so, whether it is for the best interests of society that it so passes by descent or gift to direct or collateral heirs. The answer to this class of questions is not to be derived deductively from moral or legal maxims, but from observation in practice. The reasons for a change in the policy of inheritance and descent of large estates I have already presented to the section, at some length, and may be briefly summed up as follows:

First.—Under the régime of free competition, the desire to accumulate great wealth is not only laudable, but necessary. Business and investments are by it turned into precarious lotteries. An excess of care and fortune becomes necessary to guarantee maintenance during decrepitude, the rearing of surviving children, and support of relicts, all of which might be accomplished with less capital if more complete assurance could be had. This I am persuaded ought to be and can be furnished by the State.

Second.—The further desire to secure by testamentary disposition for offspring more than an even chance in life by setting the sons up in business, or of leaving portions or dowries to the daughters after death is neither so necessary nor so laudable, if we judge by the results. It cuts the nerves of self-reliance and engenders a feeling of "great expectations," of rewards that have not been earned; it encourages parasitism and creates sharpers and their dupes, stimulates fortune hunters, and multiplies marital misery. Besides, it is contrary to good morals and sound policy to hold out the hope of advantage through the death of another, whether he be of near or remote kin. The profligacy of heirs to large fortunes, the demoralization and degeneracy of spendthrifts and their retinue need no amplification. As a contrivance to secure the marriage of daughters, it is remarkable at present chiefly for the success of the money bait in attracting the needy or degenerate holders of titles to nobility, and is no improvement on the plan mentioned by Herodotus where the more comely maidens were annually bid for at auction, the premiums going to the less attractive to whatever extent was necessary to secure a consort.

Third.—The difficulties attending succession are by no means so trifling as they may appear to those who are not put to the trouble. Public sentiment, following custom long established, dictates that a man's possessions shall be divided among his own children and blood relatives, with a reservation in favor of his widow, if there be one; and the statutes have been framed on that policy in cases of intestacy. The courts are more and more inclined to interpret ambiguous phraseology to that end, and to annul wills, or portions of wills, to the contrary tenor, except upon the clearest declaration of intention and choice of instrumentalities. This is an attempt to curtail that plea of "undue influence" which forms the basis of most testamentary contests, and which breeds scandals, family quarrels, and wasteful litigation. In olden times there was hardly a possibility of a large estate being passed without a liberal slice to the church, and many States have expressly limited the share which may thus be awarded to those not of kin or to eleemosynary institutions; others have suggestively forbidden bequests to priest, doctor or counsel in attendance during the last illness.

The draughting of probated wills reveals a disposition to withhold the principal sum from children, for which trustees are appointed, giving merely the income, the capital going to the grandchildren as being perhaps less likely to misuse it than their parents.

Fourth.—The bequests to charity, though undoubtedly in many instances perverted to founding and maintaining useless sinecures, are not so numerous nor so large as to constitute a menace to society. Contrariwise, they should be encouraged and made more general, and be more effectively carried out. At the same time the attitude of mendicancy is not favorable to manly independence or intellectual vigor, either on heirs of the blood or on institutions (unless scientific research be an exception). Philanthropic aims may be rendered more certain either by concentration into systematic method or by oversight and positive regulation from an exterior authority. It is a hopeful sign that the endowments, formerly going exclusively to churches and missionary efforts and the like, are now going more and more to technical and scientific institutions.

Fifth.—I need not discuss here the power, or the wisdom, of taxing legacies by the State; it is here, and promises to remain and grow. The only question for the sociologist now is: Shall the very considerable revenues derived from these sources be mingled with the general treasury and be expended for any or all State purposes, as in New York and many States; or, shall an effort be made to segregate this money and dedicate it to special purposes of benevolence, charity, and embellishment, thus to invite and, if wisely carried out, to win in advance the consent of the owners of large properties? I believe it is in the power of law, and within the compass of economic skill, to provide a residuary legatee for every such person superior to any other he could choose or contrive for himself, so that, in fact, it would practically make no difference whether he executed a will or not; or, if there were any difference, that the machinery provided by the State would be more sure to meet his views than any he could select. Nothing would prevent him from distributing his estate during life, if he felt so inclined; but, on the other hand, a portion of all beyond what was necessary to a competence to infants, to the disabled or incompetent, would be turned over to a department of beneficence, managed by skilled men, as are our State universities and the Smithsonian Institution, who should organize and methodize the philanthropic impulses of the rich with the ample revenues at command much better than the haphazard litigious course now open to them.

Sixth.—The same agency thus intrusted with the dispensing of voluntary as well as involuntary bequests might be availed of to do away with much of the necessity for hoarding or amassing riches, and to strip from great wealth some of the dangerous or mischievous homage paid to it, which is the cause of so much friction and clashing in lives that otherwise might be serene. Annuities might be granted for the life of the purchaser or for the life of others, objects of his care and solicitude, and thus help to banish in large measure the fear of the wolf at the door. The vicissitudes of business and health, the disappearance or loss of friends, the impatience of consanguines with enfeebled dotards, are all real causes for morbid acquisitiveness, and these might be banished by a pension or competency for life. Steady, though moderate, income is conducive to longevity, sanity and tranquillity.

By such means the benefactor who is frequently at a loss what to do with his possession could have the double benefit of using it up, or all that was of any real use to him, and at the same time of seeing the remainder of it devoted (without the scandalous shrinkage which now attaches to many of our pet charitable societies) to the erection and conduct of hospitals, asylums, reformatories, libraries, Carnegie and Cooper Institutes, memorial statues and edifices, public parks and promenades, music halls and pavilions. I hold it certain that the most avaricious of heirs would sooner see the contested wealth expended in such a judicious manner than on court costs, lawyers' fees, and the like, or than given to the opposite side. If it be objected that inheritance taxes will be evaded by gifts during life, it is easy to see that this is one of the objects aimed at—to coerce rich men and women to dispose of their excess beyond the line of competence, and to see the good or ill it works and not leave this task wholly to surviving society. There ought to be a narrower limit drawn around the power of the dead hand. Because of the sagacity to amass a fortune, there is no reason in nature why that fact should carry with it after death an authority greater than to the living.

VI. THE RÔLE OF SUPERSTITIONS.

Here let me say, we speak commonly of the sciences as if they were so many separate and independent fields of work, with distinct boundaries between them; and the division of these studies into so many different chairs in our universities, and our own classification under ten or twelve groups or "sections" tends to confirm this supposition. It should be understood that science is systematic knowledge, and the pursuit of knowledge according to methods admitting of demonstration or reasonable certainty: and that each portion is not only interlaced with its near neighbor, but all are more or less blended and interdependent, so that any great advance in one affects the others, and, of course, any backwardness keeps back the near related parts.

The old conception of science as a pyramid, whereof languages, mathematics and geometry were the basis and philosophy and theology the apex, we must now disavow; nor is it that of a circle where the several sections could be evenly joined together or taken apart, or the conception of a linear prolongation as of a tree, or vine, having roots, stem, branches and twigs, a true image. They are merely convenient symbols, but if accepted too strictly, they are apt to mislead. The present classification, like many it has displaced, is provisional and subject to reformation as a whole, as are also the component parts. While mathematics and geometry remain substantially on the bases laid out in the infancy of science, other studies, such as astronomy, geology, physics, chemistry and biology, have been completely recast; nor ought we to suppose that a finality has been reached; indeed, there are signs that portend a reconstruction to bring them all into more harmony. From his psychical, purposive and cooperative nature, man himself must always be entitled to a large and somewhat exclusive space in scientific labors in any scheme of science. Social science has not yet had its methodical reconstruction. Occupied, as it must be, largely with men's wants, motives and passions, it is essentially psychic, and awaits the evolution of the new psychology—just now renascent—before it can claim to be a science of precision and prevision. Meantime, there is much to be done; the very terminology and nomenclature, framed on the old traditional theories, will require to be abandoned or charged with new meaning to fit them to new conceptions.

It begins to look as though the wrong road had been taken in psychology, and that very much of the confusion, clashing and misery of the world is traceable to the error. It does no good, for instance, but harm, to assume as the text books do, or did, that mankind alone exemplifies the social faculty; that he alone is capable of mental development; to deny a mind or soul to the other animals, when they exhibit such human emotions as affection, fear, anger, grief, jealousy, gratitude, avarice, shame, deceit, coquetry, feigning, dreaming—attributes proceeding, so far as they go, on lines parallel to those traversed by all men in the primitive stages and by some men up to this day, but whom, on account of their backwardness, we call savages.

There is, therefore, a human and a subhuman psychology, and (if mere aggregation or association of effort and action is to be accepted as a distinguishing line of division) a subhuman sociology also, so nearly related that continual reference may be made from one to the other, as in the case of comparative anatomy and pathology. For that wide segment of psychic activities peculiar to man, in which there is not merely a consciousness of likeness, of community of burdens and pleasures, but also social purposes, aims and organized

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* "The rich have their responsibility here and their duty. Wealth and culture have a special service in their saving influence toward higher standards of thought and life and away from the raging materialism of modern society. And note that the distinction is world wide between luxury and ostentation. That which the rich desire for itself and not as the badge of precedence or the target for silly envy, they may well have—but only on condition that they rather hide than flaunt it. Society is greatly in need of lessons in plain living and high thinking. It is a fallacy to suppose the wastes of the rich are necessary for the employment of the poor. The consumption of the rich determines whether the laborer shall produce this or that, and not whether he shall produce at all. If the rich refrain in some measure from consumption, their savings profit society under the form of capital in the production of a larger social dividend. But the changing demands of vanity stand to society for more than waste and overwork. They corrupt art; they confuse and disturb the organization of industry. First, they corrupt art; no beautiful fashion, if once attained, is safe to stay. If grace and simplicity come as fashions, they go as fashions. The greed of novelty leaves the beautiful behind as antiquated, to be succeeded by the ugliness of humps and wings. From champagne to plumes of slaughtered birds, from skunk skins to jewelry, there is nothing permanent but novelty, no custom but change. And note that as soon as nothing in art which is good can abide, there will be nothing really good. When the best work can have but a butterfly life, there will be no best work."

"It is at first thought odd that unrest should especially mark the nineteenth century. The world is rich and growing richer, and wise and growing wiser. Never before would a day's labor bring so many dollars or buy so much. . . . A larger, wealthier life is open to us, and it ought to be a greatly happier life. And yet we ask ourselves what does it all profit? Pass rapidly over in thought the question whether with all our centuries of achievement we are so greatly better off than the Greeks without. Is the greater rush and push of life a good thing in itself? What does it mean that the insane asylums yearly build larger for minds unstrung by tension? How about the multiplication of suicides? Likewise our prison populations are not disappearing as the good things of life become cheaper, but theft somehow grows out of plenty.

"There is a grim paradox in civilization somewhere. Wherein do we fail, or waste, or misuse? How is it with all our opportunities? Our harvests somehow do not altogether shield us from hunger or our looms from tatters. What does it mean that as science grows and wealth multiplies, the cry of poverty swells louder and louder, and that discontent is the fixed malady of our civilization? . . . Splendor, no matter how much labor it has cost, is not splendor when it has become general. All may as well stand still as run in an equal race. Thus, material progress, so far as it is directed to competitive show, cancels itself in a strife for precedence. There is no share of gain in it for any one which does not stand for discontent and heartache for some one else. All ostentation is waste from the point of view of society as a whole. For the poor it aggravates their poverty."—Davenport: "Outlines of Economic Theory."

or systematic social efforts, in which primitive society is conspicuous (individualism being a later growth), combining plans for security, comfort, enjoyment, aspirations, opinions, creeds, culture, interdependent arts and industries, we have no better name than civilization. That I take to be the cement which binds together individuals in a relation external to that of consanguinity or ethnic derivation. There are archaic types of this culture existing contemporaneously with the modern advanced ones, the strata being curiously intermixed and overlapping barbaric traits cropping out everywhere upon civilization. The most convenient line of separation I can think of between them for the purposes of specialty subdivision is that of literature, the writing faculty being the earmark of the civilized and the lack of it of savage peoples.*

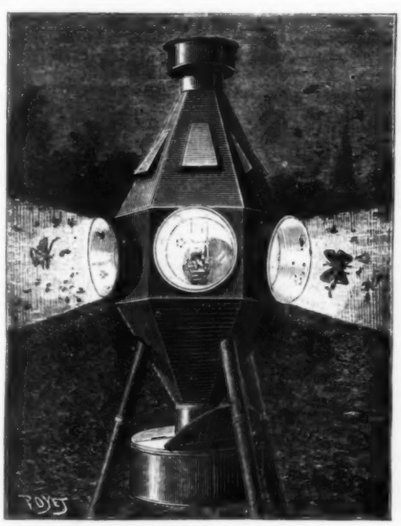
In speaking of the passion for fighting, you will notice I endeavored to account for it as being derived mainly from ancestral experience and as a trait common to man and the lower animals. We make no difficulty about accepting this explanation of those exhibitions of the mind faculty we call instincts; but in regard to the higher faculties, such as reason, will, selfconsciousness and the like, the philosophers have hitherto followed a different but not very satisfactory explanation, and have sought to reserve them to man alone. It is only within the recollection of those now living that any attempt was made to study the mind with the same freedom as any other phenomenon, and to reduce it to an experimental and comparative method; that is to say, for upward of two thousand years the notion of the duality of man had held the field, and any profane meddling with the soul, as the invisible self, ego, or personality, was deemed sacrilege, and would have met with ecclesiastical censure or penalties. The idea that the soul was something more than a function of the organism and appurtenance to it, was per se an entity, lawless, independent, directing, initiating and controlling the bodily movements and capable of maintaining a varying struggle with the passions, emotions, instincts and intellect, was probably derived from Hindostan (although the more consistent doctrine of successive incarnations by the same immortal soul was somehow dropped out in the transit) about the time of Socrates and Plato, and to them and its engrafting on the Jewish mundane religion we may attribute this long fencing off of mental phenomena from scientific observation. The plodding German metaphysics has done much to befog and encourage this cult of separable states of the mind and personality.

There are other traits besides the combative to be traced back to this race experience, such as the awe of the dead, or death bed and burial, the sense of duty or "oughtness," the propensity for lying and stealing, styled "original sin," the feeling of premonitions and of a previous existence, the craving to penetrate the future. Out of these ingrained mind traits metaphysicians have sought to construct "forms of the understanding," "categorical imperative" and innate ideas, dictates of conscience, and from these various systems of philosophy and ethics. Indeed, the claim is still maintained that there are two kinds of truth, the intellectual and the spiritual, and wherever their conclusions differ, the latter is entitled to superior validity. Confusion is thus introduced; and we have the further claim of lifting faith above knowledge, and that religion and its bases have a sphere of their own from which science is excluded. This claim scientists have not taken pains to deny, for science need not hurry, but it concerns them deeply to resent it. While the spiritual theory is defective, I am not disposed to accept the more recent one of the genesis of religious ideas from dreams, ghosts or ancestor worship. These are supporting afterthoughts. The natural wonder as to the first breath of the newly born, the last breath of the dying, the heart throb, ecstasy, suspense of consciousness, decay of mental powers, sportive variations, have helped fasten the notion of a lawless and independent double or shade which, once accepted, has led to all manner of excrescent amplifications.

Underlying this guessing at the mysteries of life, the whence and the whither, the how and the why of it, we may trace alike in man and in brute an impulse of mind or instinct which is phylogenetic, rather than ontogenetic; it belongs to the chain of descent rather than to the last individual links, in which we may discern the germ of all religious emotion. It is analogous with the embryonic progression through lower forms of structure. I mean the inborn propensity of making believe, of personification, and of poetizing in the original signification. This is the true fetishistic basis and bias; it extends to things animate and inanimate, especially if they have some semblance of animate forms. Doll inventing and pet loving are early exhibitions of it, and symbolism in art, image worship and ritualism are later ones. The inherent tendency to apostrophize, to endow or discover life or character, and to reverence is common to savages and to the children of the civilized, and is slowly outgrown by the former; while it lingers in poetry, folk lore and superstitious observances among the latter. Essentially an emotional and feminine trait, it fades with experience and the light of reason; it is probably a vestige of the period when vocal utterance was but feeble and crude and when ideas were conveyed chiefly by signs, mimicry and gesture; the gestures of obeisance, supplication and tenderness being then, as now, very impressive. Such is, I believe, the origin of worship. It has a close analogy in the palimpsestlike reappearance of old and forgotten shadows on the sensitive plate of photography after they were supposed to have been erased and then over-laid with more recent films. Religious ideas had a large use and significance in the infancy of the race and will continually crop out in spite of the culture of later time. In this respect the venerating or worshiping impulse may be likened to the sensation experienced by dramatic recitals, the excitement of the dance or the soothing of rhythmic sounds, the exhilaration of rapid motion; the instinctive clutch of the infant which cannot have experienced a fall; the lingering passion for fishing and hunting; or, to take an extreme illustration, the excited aversion of a kitten at the first sight of a dog or at the first smell of a mouse. By the light we now have we are permitted to offer a physiological explanation of phenomena of mind heretofore quite mysterious. Such puzzling phenomena as hypnosis, fascination, coincident cogitations, double and alternating consciousness, are to be solved in this way.

The time was, not so long ago, when the physiologist would hardly entertain the soul as a subject of speculation, not even in disease, insanity being accounted as possession by devils. The physicist would have thrown it out of his laboratory window, if possible. The labors of anthropologists helped greatly to lead out of that old rut. The study of mind in the multitudes, of the savage, of race traits, of mythologies, folk lore and religious ceremonies betrayed their true origin, and disclosed the likeness of origin and especially the regularity of sequences we call "laws" of thought. The biologists still further broadened the base of psychology by tracing it down through the gradations of organization to the cell, and into plant life; nor is it certain that it stops with life, as we at present define life, but seems to be coextensive with organization.*

Science does not, in one sense, concern itself with teleological suppositions; that is to say, it is reluctant to resort to any of them to explain the observed cosmos, and prefers to listen in a neutral attitude to the rival philosophies—theism, manicheism, atheism, monism, spiritism or materialism; but it is at least equally well equipped to pass judgment on any such speculations as their advocates. The attempt to waive students off from the domain of the soul or from religious beliefs and observances is likely to be disregarded. In fact, the educated ecclesiastic mind now anxiously awaits the verdict of science on the nature of mind, and the origin of some of these innate ideas. When it is found that they are naturally accounted for as belonging to the experience of the race, something not to be ashamed of and still less to be proud of, and are not likely to be superseded very soon, the doctrine will be welcomed as one averting a threatened dissolution. So long as the perpetuity and acceptance of the church dogmas was based upon the inspiration of certain writings, upon miracles, upon special providences, soul peril and soul rescue, or future rewards and punishments, it was exposed to the double risk and cross fire of successful contradiction by science, and by historical criticism, and also liable to the ridicule of scoffers and the charge of outrageous fraud. Science is now on the eve of supplying a broader and more enduring, or at least less precarious, basis for religious ideas than its votaries. When Pope Pio Nono was told that science was undermining some of the foundations of the church, he exhibited a profounder knowledge of human nature and soul nature than the casuists by his reply: "Then we must revive more relics and shrines."



RÖRIG'S LAMP FOR THE DESTRUCTION OF INSECTS.

Dr. Andrew D. White has rendered a special service to scientific research and also to ecclesiastical training by his compilation, with abundant citation of textual proof, of the successive awkward retreats from this position of superior spiritual discernment. Whenever the psychologists are ready with the lacking capstone of experimental observable proof as to the act of thought, the further measurements of its velocities, and transformations of matter or motion into that we call consciousness, they will be listened to with profound attention. No propaganda is needed to enforce the conclusions of science, the intelligible statement is enough to overcome the most unscrupulous opposition. What is now waited for is a psychic spectrum to throw as upon a screen the analysis of mental phenomena and to give the equivalent of Fraunhofer's lines in perception, memory, comparison, association, ratiocination, the several emotions below and above the limits of consciousness, and especially to picture for us those puzzling subconscious states the mirages of the will and the self-examination. We may confidently expect (probably from another rash layman) some form of mental bolometer which shall record for us the dimensions and count the number of the vibrations of this hitherto unsuspected mode of motion, if not also to disclose those delicate films which carry some but not others of those external stimuli down to posterity, and fix the stamp of ancient habits, passions and character long after their necessity or utility has vanished. Is it any more wonderful than that the two forces of heredity and evironment should preserve the bodily forms and organic structure for a like period? After the publication of Haeckel's famous work demonstrating that man himself in embryo, and often in life, bears the evidence of derivation from, and similarity of nature with, the lower animals, it is not incredible that these mental traits should accompany them for the latter part of the period. As passing from mother to child, we accept them along with the physical features unquestioned. We easily detect them for three or four generations. Why not for ten thousand composite impressions? One is tempted to use the exclamation of Huxley after his first reading of the "Origin of Species:" "Why, how stupid of us that we never thought of that before!"

The retrospect extending so far back enables science to look forward a trifle. The decay of faith, and the crumbling of dogma already giving anxiety to thoughtful men within the ecclesiastical pale, is giving rise to the question: "What is to become of morality when its supernatural sanction is lost?" Prof. Goldwin Smith, from the historian's point of view, naturally apprehends a serious jolt, and doubts whether the present structure of society can stand the transition. The view here taken may reassure the timid. The doctrines which are causing such naïve embarrassment: the fall of man, the atonement, the resurrection of the body, the real presence, anthropomorphic deity and filiation, angels, devils, future rewards and punishments, may fade out and disappear—may, in fact, be relegated to the region of extinct mythologies—but the underlying religious idea, the worshiping instinct, will remain. It is as perennial as the belief in fairy tales, nuptial revels, bereavement, serpent fear, omens, portents, myth making, charms, amulets, lucky stones, and ceremonial superstitions; and having the same ingrained origin. They are vestigial experiences of the race—an inheritance to be outgrown, but meanwhile costly impediments.

DESTRUCTION OF INSECTS.

THE problem of the destruction of noxious insects is more difficult of solution than might be supposed. Insecticides are found inadequate, sulphide of carbon, nicotine, emulsion of soap, tar, essential oils, naphthaline, petroleum and sulphate of iron, not to speak of secret compositions, have been recommended. Despite everything, the ravages continuing to increase, the public authorities have occupied themselves with the question. A decree of December 24, 1888, concerning the destruction of insect pests, replaced the old law as to the destruction of caterpillars that was but slightly or not at all enforced. After insecticides, a trial was made of traps and other apparatus designed for capturing moths, flies, butterflies, beetles, etc., by the wholesale. On another hand, M. Finet has devised a permanent evaporator, composed of a glass bottle having a lateral aperture closed by a cork, and which is suspended from the branches of a tree after being filled with a peculiar insecticide. These bottles, to the number of one per square meter, are placed on plantations.

M. Martre invented the tannophore, an apparatus designed to disengage vapors of tobacco juice in greenhouses. But these processes are used locally only. It was but natural to think of utilizing the influence of light and fire upon insects.

M. Gaillot constructed a very popular automatic torch for the destruction of the nests of caterpillars and plant lice. Then a return was made to lanterns, which are sometimes obscured by clouds of phryganids, phalænids and ephemera.

In certain districts it is customary in the evening to light bright fires into which moths and other insects fly and are burned. These curious experiments have been put to profit to effect better work still.

Trunks of trees, boards and vessels have been smeared with honey, molasses and other saccharine substances to which the insects adhere when they come into contact therewith.

In the Journal d'Agriculture of August 20, 1892, we find a description of a trap for the destruction of the cochylis, devised by M. Besnard, of Paris. Two or three of these traps to the acre are sufficient, it seems. The apparatus consists essentially of a lamp surrounded with a conical frame of galvanized iron wire smeared with bird lime, which captures lepidoptera. It is not only moths that can be destroyed in this manner, but also all noeturnal lepidoptera and coleoptera. But, among the new methods that are most apt to give entire satisfaction, we believe that one of the best and most practical is the apparatus invented not long ago by Dr. Rörig.

The following is a brief decription of this apparatus, which we illustrate herewith:

A lamp is inclosed in a hexagonal lantern, every side of which contains an aperture which is provided with a strong lens preceded by a conical reflector through which insects, attracted by the light, can enter. At its upper part the lamp is formed of a pyramidal cover provided with ventilators that allow of the exit of the hot air, but preventing the escape of the insects. It is closed at the bottom by a pyramidal base that leads to a reservoir into which is put a saccharine and odoriferous mixture that attracts the insects. The latter, after entering the lantern, are unable to make their exit therefrom and slide into the lower receptacle, which it suffices to empty from time to time. The diameter of the lantern is 0·31 m.; the sides are 0·15 m. square, and the diameter of the front aperture is 0·13 m. The instrument is placed in a tree or in the open field.

The expense of keeping the apparatus in working order is very small. The present price of the lamp, however, is too high to allow the use of it to become

* If the present classification is to stand, anthropology covers all human affairs and thoughts—a field too vast for a single mind to master in all its detail. Ethnology, archæology, somatology and spoken languages would seem to belong to it somewhat exclusively. How, then, are the remaining human activities to be divided, such as civics, politics, demography (vital statistics), economics, ethics, æsthetics, arts, industries, education, creeds, opinions, folklore, linguistics? Dr. McGee, in a very commendable scheme of anthropology, has used the word sophiology as a generic title for the more psychic of these, which seems to me to be a more scientific and more natural line of cleavage (and one which will appeal to the sense of responsibility of the council) than sociology—a hybrid at best, which not even the brilliant sponsorship of Comte, Spencer, Giddings, Small and others in professorial chairs can reconcile with other sciences. Any arbitrary line of separation is attended with difficulty; but if these studies could be divided into two or three departments, it would tend to reflect the present trend of research.

* For opinions on the coextensiveness of mind with life and organism see Haeckel's "Creed," E. D. Cope's "Primary Factors of Evolution" (concluding chapter), Darwin's letters, Clodd's "Pioneers of Evolution," Romanes and others, Neo Lamarckians and Neo-Darwinians.

For expressions on the pervading reach of mind, as exhibited in unorganized matter—as a property of matter—in the curious behavior of substances like camphor grains, gamboge, frost crystals on plate glass, figures on vibrating membrane, see current literature of physics and chemistry, Prof. A. E. Dolbear's "Matter, Ether and Motion," also the concluding sentences of his lecture to Wood's Holl Biological Station: "At any rate it is evident that if any such theory of matter as is here presented be true, and if the behavior of matter as we see it in the test tube and microscopic slide has been interpreted with any approach to the truth, then it is a much more wonderful thing than the old philosophers thought; its possibilities greatly exceed what could before have been imagined; and if mind itself requires a material habitat, then it has in an atom an imperishable living house."

common. It would be easy to simplify it by adopting a less costly arrangement, and farmers might then use it with great profit.—La Nature.

THE PUNIC NECROPOLIS OF DOUIMES, CARTHAGE.

Toward the end of the summer of 1893, the Rev. Father Delattre began a series of excavations at Douimes, Carthage, which resulted in the discovery of an interesting and extensive necropolis. By the month of November of that year he had opened upward of sixty tombs. One of these, discovered on November 28, was

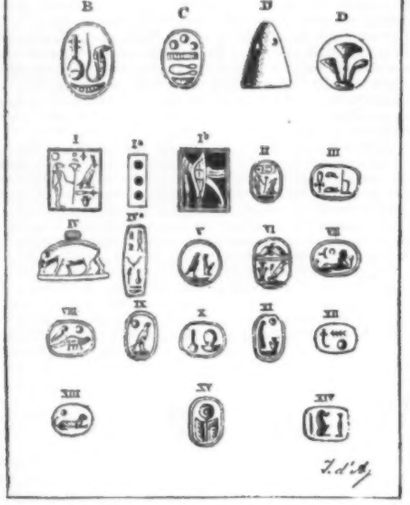


Fig. 1.—CARTHAGINIAN SCARABÆUS AND AMULETS.

double, and constructed of beautiful slabs of tufa, the only kind of stone employed in the primitive Carthaginian structures. Each compartment was 2·05 m in length, 0·75 m. in width and 1·10 m. in height. The two mortuary receptacles were put in communication by an aperture in the median partition. In one of the compartments there were found, in addition to the usual objects (double urn, amphora, lamp and patera), alongside of the skeleton, two nearly hemispherical vessels with a conical appendage upon the belly, a ring, and a scarabæus bearing three hieroglyphic characters reading: "Râ is the true ichneumon"—an allusion to the worship of the ichneumon and to its identification with Râ. The Egyptians, in fact, worshiped the ichneumon or Pharaoh's rat (Herpestes pharaonis).

The scarabæus in question is reproduced in No. VIII of the accompanying Fig. 1. The following is, according to M. Maspero, an explanation of the pieces reproduced in this figure: B and C are scarabæi carrying a device that had no meaning except to the possessor.

Fig. 2.—SCARABÆI.

D and D¹ represent a cone worn as an amulet. At its base is seen a tuft of lotus.

The rectangular tablet that carries the first number is of a whitish material and provided with three apertures. One of its faces shows the "oudja" or eye of Osiris, and the other bears a scene of Egyptian mythology thus interpreted by M. Maspero:

The goddess Sokhit, crowned with the disk, a scepter in her hand. Her name is written in front of her. In front, the banner name "Horou âa hiti," the magnanimous Horus of Pharaoh Psammetichus of the XXVIth dynasty.

M. Maspero remarks that this very delicately executed amulet certainly gives the highest limit to which we can carry the age of the tomb in which the object was found.

Psammetichus, who founded the twenty-sixth dynasty, was one of the twelve kings who divided the government of Egypt between themselves after the death of Pharaoh Sethos, whom a statue represented, rat in hand, with this inscription: "Learn by my example to respect the gods." It was doubtless the ichneumon that Sethos thus presented for the veneration of the Egyptians. Psammetichus reigned from 671 to 656 B. C. over the northwest part of Egypt, to the east of the Delta. He succeeded in driving out his colleagues, and afterward reigned alone until the year 617. It is related of him that he built temples at Memphis in honor of the bull Apis and of Phtah. This Pharaoh called foreigners to Egypt, had a navy organized and tried to conquer Phenicia.

These details show on the one hand that the tomb that contained the amulet above described cannot date back further than the seventh century before the Christian era. This, moreover, will establish the date of the most ancient objects found in the necropolis.

Scarabæus No. II. Upon the corbel is seen the

Fig. 3.—GOLD EARRING AND NECKLACE BEAD.

cartouche of Menkaouri (Mycerimus, the Mycerinus of Herodotus and the Mencheris of Manetho), the founder of the third of the great pyramids of Gizeh. Above is the title, "Horou noubi," the Gilded Horus, the Victorious Horus and the goddess Sokhit with the lioness' head, in the same posture as in the preceding number.

The style, says M. Maspero, indicates the "saite" epoch. The name Menkaouri, like that of Thoutmosis III (Mankhopirri) or of Amenothes III (Nibmaouri), was reproduced at all epochs by way of an amulet, on account of the mystic sense that it possessed.

No. III. Isis Onkhit, "the living one," a female proper name or one dedicated to the goddess Isis, whose name would be followed by the frequent epithet "onkhit," the living one.

No. IV. Amulet in the form of a sow or hippopotamus. Upon the plate is read: "Phtah, good messenger who protects the entire earth (Egypt)."

No. V. The god with hawk's head, and the hawk of Râ upon the corbel.

No. VI. Har-Khobi, Horus of Bouto, upon the corbel. M. Maspero seems to think that the winged disk transformed into a bird proves the Phenician origin of the object.

No. VII. Sphinx. The characters above may be Phenician. They have not been deciphered.

No. VIII. This is the scarabæus already spoken of. We read here: "Râ is the true ichneumon."

No. IX. Râ and Horus upon the corbel, a formula having no signification except to the owner.

No. X. "Râ is the good master."

No. XI. Nebmâirî, "a master of the truth is Râ."

No. XII. Name of the moon god Thebain, son of Amon and Mout.

No. XIII. Râ or the sun god and a lion.

No. XIV. The cynocephalus Thot, whose voice enchants by its magic power.

No. XV. The disk of the sun surmounted by two feathers.

The description and sense of these few scarabæi show the relation that existed between Egypt and Carthage from the view point of customs, religion and commerce.

The excavations were continued at intervals between December 29, 1893, and January 31, 1894, and besides the usual objects, there were discovered some Greek vases, some unguentaria of glass and alabaster, some ostrich eggs, some copper and bronze mirrors, some earrings, (Fig. 3), some amulets, and, finally, two bronze scale pans and a series of lead weights. These weights (Fig.

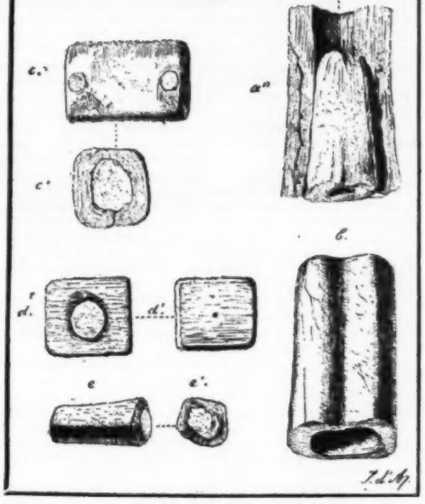


Fig. 5.—CARTHAGINIAN BONE WEIGHTS WITH THE ADJUNCTION OF LEAD.

4), which were nine in number, were all truncated pyramids in form, and of square section. Six of them were marked with a peculiar sign. The following were their respective values in grammes: 188·6, 96·7, 44·6, 24·6, 11·13 and 9·12.

The first set of weights found in the Douimes tombs was of lithographic stone of a greenish color and smooth and soft to the touch. It consisted of six weights. The largest of these was rectangular in form and weighed 89·8 grammes. The others were of the form of a truncated pyramid, with the exception of a round flint stone, which appeared to have replaced one of the weights wanting in the set. The respective values of the weights, in grammes, were 45·45, 23, 11, 42, 4·65 and 25. The smallest weight was marked with the Punic letter eh. The signs that the others bore were not alphabetic characters.

Another set was of bone with the adjunction of lead (Fig. 5). In view of the material, the value of these weights could not necessarily be as exact as that of the metal or stone ones. The following are the respective values of them in grammes: 99, 35·2, 19·8, 19·5, 8·4 and 3·15. For the above particulars and the accompanying engravings we are indebted to Cosmos.

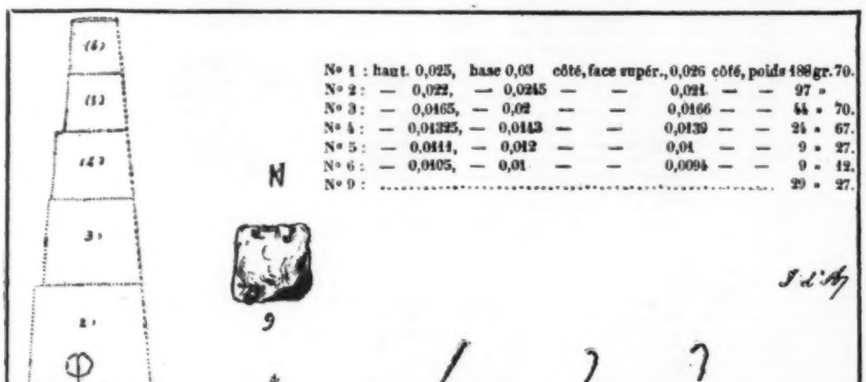
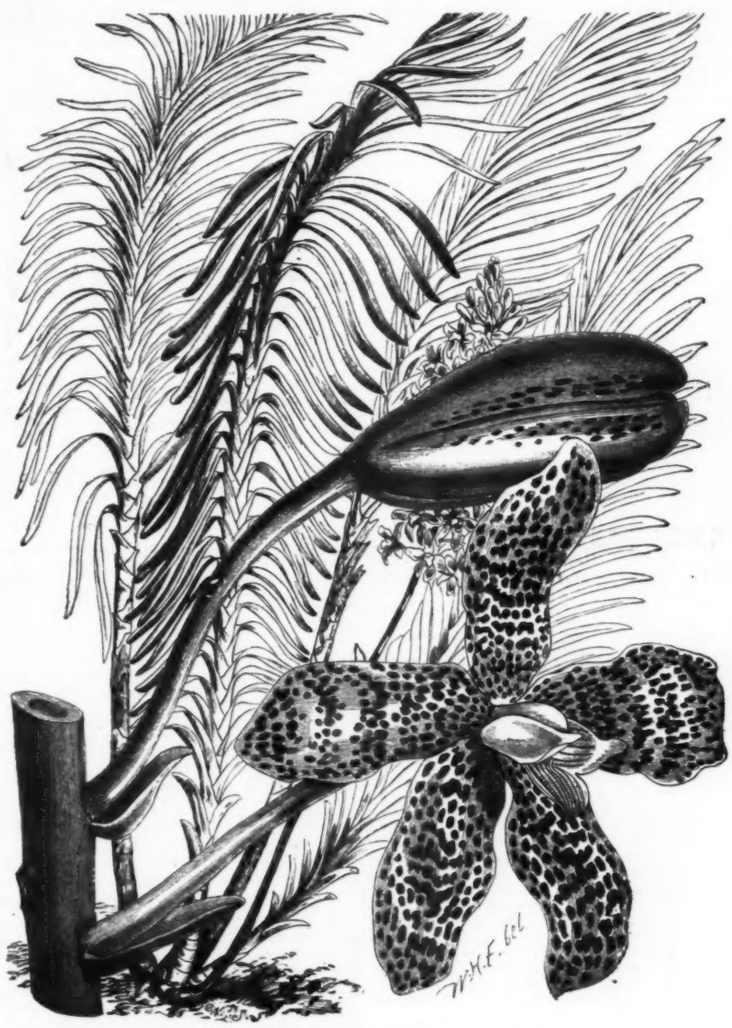


Fig. 4.—CARTHAGINIAN LEAD WEIGHTS.

GRAMMATOPHYLLUM SPECIOSUM.

THE event of the week, horticulturally considered, has been the exhibition of a noble spike of this orchid by Sir Trevor Lawrence. An idea of it can be gleaned from our figure, repeated from a former volume. At the bottom of the spike in Sir Trevor Lawrence's plant were two abnormal flowers, one of which is figured in our engraving. This flower had four nearly equal segments in two rows—no true lip and a straight column—a very common state of things among orchids, and interesting as showing the probable derivation of the ordinary irregular orchid flower from a regular type. The plant is recorded to have flowered first in 1851 in Loddiges' nursery at Hackney, while a much finer specimen appeared in 1859 in the garden of W. G. Farmer, Esq., Nonsuch Park, Ewell, and subsequently another was flowered by Mr. Scott, gr. to Sir G. Staunton, Leigh Park. Mr. Curtis, of Penang, a few years since sent us a photograph of a magnificent plant of this species of dimensions that we hesitate to cite. Unfortunately, the photograph was unsuitable for reproduction. Another fine but much smaller specimen was imported by Messrs. Sander & Company, of St. Albans. We gave a figure of the extraordinary snakelike pseudo-bulbs denuded of leaves, and with its curious ascending roots, at the back page of the index for vol. xiii, 1893. This specimen was presented to the Royal



GRAMMATOPHYLLUM SPECIOSUM.

Spike 7 feet high; flowers 5 inches across.

Gardens, Kew, by Messrs. Sander, and forms now one of the most striking objects in the Victoria house. The roots have access to the water, and the plant is in vigorous health, and will no doubt flower in another season. The plant is a native of Java and other islands of the Indian Archipelago. The prevailing color of the flower is dull yellow, thickly dotted with reddish purple spots. The pseudo-bulbs attain a height of 9 to 10 feet, and the flower scape measures 6 feet and upward in height. The flowers measure 5 to 6 inches across.—The Gardeners' Chronicle.

[Continued from SUPPLEMENT, No 1134, page 18132.]

THE SPREAD OF LAND SPECIES BY THE AGENCY OF MAN; WITH ESPECIAL REFERENCE TO INSECTS.*

By LELAND O. HOWARD, Ph.D.

IN considering the question as to the regions with which an interchange of forms is most likely to occur, it is obvious that they are those which have the greatest similarity of climate, and, most nearly, identity in point of time or seasons; those, in fact, which are most likely to afford similar environmental conditions. A study of the similarity of faunas and floras already existing will lead us to the same result. Wallace has pointed out that with the Coleoptera the best marked affinities between regions are those between the Nearctic and the Palearctic, the Oriental and Australian, the Australian and the Neotropical, all of which appear to be about equal in each case. Next comes that between the Ethiopian and the Australian on the one hand and the Ethiopian and the Neotropical on the other, which also appear about equal. Then follows that between the Nearctic and Neotropical regions, and lastly, and by far the least marked, that between the north temperate and south temperate regions.

Further, in the consideration of accidental commercial importations, the amount and frequency of commercial interchange and the rapidity of the journey are most important factors.

From all of these considerations combined we arrive at the conclusion that the regions with which accidental interchange of species should be most frequent are Europe and North America, and this is with insects to a certain extent borne out by the facts. The introduction of species from Europe into North America is of everyday occurrence and their establishment is far from rare. The carriage of American species to Europe is an equally frequent matter, but their establishment is much less frequent.

I have studied in this connection—my profession being that of an economic entomologist—principally the species which are prominent as injurious to horticulture or agriculture or in other ways inimical to man. Listing the insects of prime economic importance in the United States, the species each of which almost annually causes a loss of hundreds of thousands of dollars, we find that they number seventy-three. Of these thirty are native, while thirty-seven species have been introduced, six species being of doubtful origin. Of the thirty-seven introduced species, thirty have come to us from Europe, all, with one exception, as accidental importations.

Of the prominent European injurious insects, on the other hand, but three are said to have come from America; the grapevine phylloxera (Phylloxera vastatrix), the woolly root louse of the apple "American blight" (Schizoneura lanigera), and the Mediterranean flour moth (Ephestia kuhniella). Of these but one is certainly American—the phylloxera. The origin of the Schizoneura is somewhat doubtful, while the Mediterranean flour moth is not American, but probably came to us from Europe, although originally it is probably Oriental.

As with these insects of prime economic importance, so it is with other less noted species. There have been rather frequent establishments of European species in America, but practically none of American species in Europe. The reason for this curious condition of affairs is difficult to find. The general trend of accidental importations seems to have been westward, and it is doubtless a fact that certain of our now cosmopolitan forms were originally Asiatic and have traveled westward, through Europe, to and across America, and thence to Hawaii, New Zealand and Australia. The existence of such a law is borne out in the study of plants as well. The statement just made regarding insects of prime economic importance is almost exactly paralleled with the plants classed as weeds. It has thus been shown that, out of two hundred American weeds, one hundred and three are introduced, of which ninety-six are from Palearctic regions, sixty-eight being native to Europe, while it seems that less than half a dozen American species have become troublesome in Europe. A number of American species, however, have been carried to Australia and flourish there with vigor.

This general trend from east to west has always been in the direction of the newer civilization—from the older civilization to the newer. That this in itself is significant cannot be doubted, and in the case of the insect and plant enemies of agriculture the facts surrounding this condition are almost in themselves sufficient to account for this direction movement. I have shown in another paper that the denser population of the older countries and the resulting vastly smaller holdings in farms, the necessarily greatly diversified crops, the frequent rotations of crops, together with the clean and close cultivation necessitated by the small size of the holdings, and the cheaper and more abundant labor, will all operate as a barrier against the establishment of injurious species, while the reversed conditions in a newer country at once liberate an introduced species from the repressive conditions which affected it in its original home and encourage its establishment, multiplication and spread. But there are deeper causes than this at work. It has been suggested that the flora and fauna of America, the older continent, have become degenerate through age and cannot successfully resist competition with the more vigorous forms introduced from the younger continent of Europe,* and that there are not-yet-formulated climatic differences favorable to the development of Palearctic forms on the American continent; but these theories seem unsusceptible of proof, and for the present we must content ourselves to accept the facts as we find them.

The insects which are accidentally imported are carried in three main ways. Either (1) they are unnoticed or ignored passengers on or in their natural food, which is itself a subject of importation, such as nursery stock, plants, fresh or dried fruit, dried food stuffs, cloths, lumber or domestic animals; or (2) their food being the packing substances used to surround merchandise or the wood from which cases are made, they are thus brought over; or (3) they may be still more accidental passengers, having entered a vessel being loaded during the summer season, and hidden themselves away in some crevice. The colopterists (Hamilton and Fauvel) make a distinction by name among these classes, calling the first group "insects of commerce" and the latter "accidental importations."

It would appear on the face that these more strictly accidental importations must be rarer than those which are termed commercial importations, yet of the 156 introduced Coleoptera recorded by Dr. Hamilton in 1889, sixty only were considered by that writer as insects of commerce, while 96 he thought had been brought over in this accidental way.

The remaining Coleoptera common to North America and the Palearctic region, 278 in all, Dr. Hamilton considers to be practically circumpolar species, or at least not imported. Fauvel in his remarks and additions to Hamilton's catalogue raises the number of non-introduced or circumpolar species to 366, leaving 125 as imported, of which only 28 appear to have been imported from temperate Europe, the rest being cosmopolites or subcosmopolites. Of the latter class he thinks that 59 originally came from the temperate Europeo-Siberian fauna, 10 from the Oriental fauna, 15 from the Ethiopian, 4 from the Neotropical, 7 being uncertain and 2 unknown.†

It should be noted, however, that there is grave room for difference of opinion regarding a number of the European species considered by him as indigenous to North America. Scolytus rugulosus, Hylastinus trifolii, Anthrenus scrophulariæ, Sitones hispidulus, Cryptorhynchus lapathi, and a number of others which might be specified for example, have undoubtedly been imported from Europe and were quite possibly originally imported.

There are obstacles in the way of the establishment and spread of species which are imported quite by accident which usually do not exist in the case of the so-called commercial importations. In many cases, entering the vessel by accident, they exist there as single individuals, and upon liberation, even should the conditions be favorable, only gravid females could perpetuate the species. Then also the majority of such specimens are liberated upon the unloading of the vessel upon the wharves. The water front of a seaport city is not a favorable place for the establishment of a species which feeds on living vegetation. Frequently, even when it is a species well fitted for acclimatization, it will have to fly or be carried for miles inland before it can find a place possible for the establishment of the species. So it happens that while foreign insects are frequently found in living condition about the wharves of our larger seaports during the summer months, almost none have succeeded in getting a foothold in the vicinity. Mr. Otta Lugger, when living in Baltimore, Md., made a collection of many species of foreign insects found upon the wharves, yet he has recorded the establishment of but a single species, viz., Aphodius erraticus, a European dung beetle, which managed to get to Druid Hill Park, where it bred in the dung of the tame deer, afterward spreading into the surrounding country and breeding in the dung of sheep and other domestic animals.

Practically, therefore, after many years of the most active commerce, the insect faunas of the immediate vicinity of the larger seaports, like New York, Boston, Philadelphia and Baltimore, have not been greatly changed by the introduction of foreign elements.

All of the household insects and true city insects are, of course, exceptions to this conclusion, and the strong flying, vigorous, and simple living dipterous insects—

* Paper read before the Zoological Section of the American Association for the Advancement of Science, August, 1897. A portrait of Doctor Howard will be found in the SCIENTIFIC AMERICAN of September 25, page 195.

* The spread of European species in Australia has been explained by the superior energy of the younger races of the Palearctic region.

† Hamilton, in his 1894 paper, raises the number of Coleoptera common to the two countries to 394, making the number of introduced species 218.

the very ones most likely to enter a loading vessel and to escape on the discharge of its cargo—will many of them find proper places for breeding. It is likely that a much larger proportion of the many species of Diptera common to Europe and North America have been brought over in this accidental manner than is the case with the Coleoptera.

But often these purely accidental species are carried inland in packing cases, into the cracks of which they may have crawled, or even in the trunks of passengers, and they may then be liberated in more favorable localities. For example, Mrs. H. G. Hubbard, after spending the summer on Prince Edward's Island, returned in the autumn to Detroit, Mich., and in unpacking her trunks her husband found two specimens of Phytonomus punctatus, a species not previously known to occur in Michigan, although found there in injurious numbers a year or so later. It is altogether likely that the imported elm leaf beetle (Galerucella luteola), an insect which enters houses for hibernating purposes, was first brought to America in this manner.

It is, however, the accidental commercial importations which theoretically stand the best chance of establishing themselves, since, in the first place, they are generally imported in or upon their natural food. In the second place, they generally occur in considerable numbers, instead of as isolated individuals, as with the more purely accidental importations; and, in the third place, they are usually carried as originally packed, far from the port of entry.

With insects brought over on plants or nursery stock the conditions could not well be much more favorable. Their supply of food is looked after with care, the host plant is soon put in the ground under the best of surroundings, and the greatest care is taken of the choice importation. Upon or in importations of this kind are carried Coccidæ in all stages of growth, and often, fortunately, their inclosed parasites, the eggs of Aphididæ, the larvæ of wood boring Coleoptera, the eggs of many other insects, the cocoons of small Lepidoptera, and probably even in rare cases the larvæ of Lepidoptera, since it now seems likely that Euproctis chrysorrhœa was imported into Massachusetts on nursery stock in its larval hibernacula. The Coccidæ, however, are most abundantly carried in this way. Under natural conditions these insects have usually a rather restricted distribution, but by means of this commercial distribution many of them have become of almost world-wide range, and the end will certainly not be reached until every country possesses every species of scale insect which can possibly live in its climate. A few instances drawn from a recent paper by Mr. Cockerell will illustrate this fact:

Diaspis amygdali, or lanatus, was described from Australia in 1889. To-day we know it from Australia, Ceylon, Hong-Kong, Japan, several localities in the United States, Jamaica, San Domingo, Grand Cayman, Barbadoes, Martinique, Trinidad, and Cape Colony.

Aulacaspis rosæ was described from Europe, but is now found also in the United States, Australia, New Zealand, the Sandwich Islands, China and Jamaica.

Chionaspis citri was described from Louisiana and Cuba in 1883 and is now known from Trinidad, Antigua, Demerara, Bermuda, Mexico, Tonga, New Zealand and Australia.

Howardia biclavis was described in 1883 from specimens on hothouse plants in Washington, D. C. Now it is known out of doors from Trinidad, Mexico, Tahiti, Sandwich Islands and Ceylon.

Lecanium oleæ is found in Europe, the United States, the West Indies, Mexico, Sandwich Islands, New Zealand, Australia and Cape Colony.

The hymenopterous parasites of the Coccidæ, by virtue of their mode of life, have spread almost equally with their hosts by means of this commercial transportation. I have been able to show recently that by this means a number of species of the Chalcidid subfamilies Aphelininæ and Encyrtinæ have, in comparatively recent years, become cosmopolites. For example:

Aspidiotiphagus citrinus, originally described from California in 1891, is now found in many other portions of the United States, in the West Indies, Italy, Austria, Ceylon, China, Formosa, Japan, Cape Colony, Queensland, South Australia and Hawaii. Practically the same remarkable distribution is followed by Prospalta aurantii, Aphelinus mytilaspidis, A. diæpidis and A. fuscipennis, while the remarkable and system-breaking Encyrtinæ, Arrhenophagus chionaspidis, described by Aurivillius from Swedish specimens in 1888, has since been found in Austria, Italy, several portions of the United States, Ceylon, Japan, Formosa, and China.

Only second to the Coccidæ in the facility with which they are transported in this way are the Aphididæ. These insects, however, are fragile, soft bodied and unprotected. They are readily carried, however, in the winter egg condition, and many species are rapidly becoming cosmopolitan. They have not been studied, however, elsewhere than in Europe and the United States, and the extent to which this commercial distribution has been carried can only be surmised. A suggestion of this extent, however, occurred to me when within the past few weeks specimens of Aphelinus mali, a common parasite of Aphididæ in Europe and North America, were received from such a comparatively out-of-the-way corner of the world as Passarean, Java.

Other still smaller and still less studied insects are undoubtedly carried by this method of transportation, as the recently discovered identity of certain North American Thysanoptera with those of Sweden and Russia would seem to show. The small plant-feeding mites of the family Phytoptidæ are particularly subject to this form of commercial distribution, and when they are fully studied, it will doubtless be found that many forms have become subcosmopolitan.

Of larger insects, nearly all of the wood-boring beetles common to Europe and the United States have probably been brought over in this way. Zeuzera pyrina, the large wood-boring cossid moth, also probably came over on living plants; and, as I have just stated, the newly imported brown tail moth, Euproctis chrysorrhœa, was probably at Boston with nursery stock.

Careful observations on the insects transported with this class of merchandise have never been made, except possibly at the port of San Francisco. At this port the State Board of Horticulture has established under State laws a quarantine for all incoming plants and fruit. The entomologist and quarantine officer, Mr. Alexander Craw, has entire jurisdiction over such articles consigned to points within the State, and examines, destroys and fumigates at his discretion. He has not, however, in his reports given us complete lists of the insects collected in this work, although I understand from persons who have visited his office that he has preserved collections of the more important species from an economic standpoint. The vessels examined have, almost without exception, come from Pacific ports, and the difficulty of naming insect material thus received would be very great. It is this fact which has probably hitherto prevented the publication of a general list. A list of the scale insects, however, has been published.*

Between July 2, 1894, and August 29, 1896, Mr. Craw inspected 232 vessels carrying plants or other articles liable to be infested with living insects and consigned to California individuals or firms. One hundred and twenty-two lots he found clean and passed; 40 lots he admitted after fumigation; 20 lots he destroyed and 78 lots he destroyed in part. One lot, consisting of 1,000 boxes of apples, he sent back on the refusal of the owner to allow them to be fumigated.

Living plants and nursery stock afford, then, perhaps, the most certain means for the accidental transmission and subsequent establishment of many kinds of insects. Commerce in objects of this class is rapidly increasing, and has already assumed considerable proportions, the imports into the United States alone in the fiscal year ending June 30, 1896, having reached a value of nearly $1,000,000, while the previous year they amounted to something over $600,000.

No great elaboration will be needed concerning the importation of foreign insects upon fruits, fresh and dry, other dry food stuffs, cloths, lumber or domestic animals. Fruits were imported into the United States in the fiscal year 1895-96 to the value of nearly $20,000,000, and, unquestionably, upon imported fruits are carried many insects. The opportunities for the establishment of species coming with fresh fruit, however, are obviously slight as compared with those which come on living plants or in dried foodstuffs, and, as a matter of fact, it appears that already nearly all of the dried food insects have become cosmopolitan. The same may be said of the insects which affect domestic animals. The forms which are truly parasitic in the larval stage have most of them been carried everywhere, while the other forms which attack domestic animals only as adults have some of them been carried far and wide. As an example, we may recall the European Hæmatobia serrata, which was brought to New Jersey probably in 1886, and which has spread over the entire country from Maine to California.

The fact that insects may be, and doubtless are, transmitted in the material used in packing heavy or delicate merchandise must not be overlooked. We have already shown that dangerous weeds have been transmitted in this way, and when the material is hay or straw the danger of importing certain injurious insects becomes great. Cecidomyia destructor, the well known Hessian fly, is supposed to have first been brought to the United States from Europe in straw bedding on troop vessels during the war of the revolution, and to have recently been carried from Europe to New Zealand in the straw packing of merchandise. Laws recently proposed in New Zealand, Australia and Cape Colony provide that such straw or hay packing shall be burned immediately the case is opened. Dr. H. Loew, in his well known paper, "Ueber die Diptern-fauna des Bernsteins," has shown that several of the species of the genera Oscinis and Chlorops have gained a wide distribution through commerce, and this probably happened through their occurrence in hay or straw used as packing, since they live in the stems of grains and grasses. Dr. Loew, by the way, considered the Diptera, by virtue of the simple conditions required for their existence, to be peculiarly susceptible to commercial and accidental distribution, and was inclined to believe that the majority of the many species common to Europe and North America have been imported into the latter country. He understood, however, the existence of a circumpolar fauna, and wrote wisely and learnedly about the common ancestry of what he called analogous species. Whatever may be the cause, the Diptera seem fitted in the individual to withstand widely differing environmental conditions. The group as a whole has apparently little faunistic value either along broad lines or in a more restricted way. There are comparatively fewer characteristic genera in the main faunal regions of the world than in other groups of animals, and in our own country there are comparatively few species of restricted distribution. Very many individual species range through the Lower and Upper Austral, through the Transition and into the Boreal regions.

Aside from the Diptera, grains and grasses all over the world are subject to the attacks of a host of insects of all kinds, many of which hibernate on or within the stems, so that the proposed legal provisions of the English colonies mentioned are by no means unwise. The substitution of the wood material known as "excelsior," the use of which is becoming so common in this country, or of some other packing material, will shortly do away with a large share of this danger.

There are, of course, other less important methods by which insects may be transported, such as in earth or damp moss about the roots of plants and in sand used for ballast. These methods, however, are not very important as a rule, although it is stated that the destructive chigoe (Sarcopsylla penetrans) was carried in ballast in 1872 on a vessel from Rio Janeiro to the coast of Guinea, where it has established itself most perfectly, having been found two hundred miles inland by Stanley.†

(To be continued.)

* Bull. 4, Tech. Ser. Div. Entom. U. S. Dept. Agric., 1896, pp. 40, 41.

† Die Umschau, July 17, 1897, p. 523.

Aluminum is now used in making clock hands, for which it is an ideal material. The pointers of great clocks were formerly made of soft wood. For these were substituted pointers made of thin sheets of copper, a pointer being composed of two strips, which were cupped or hollowed, and then brought together edge to edge, with the rounded sides out, thus giving rigidity as well as lightness. Aluminum pointers for big clocks are made in this way, but they are far lighter and easier to balance. It is not unusual on large clocks in windows and elsewhere to see projecting from the base of the long pointer and in line with it a rod with a ball at the end, this rod being perhaps a third as long as the big pointer. This rod and ball are a counterweight for the big pointer, which, without a counterweight, would, in its movement around the dial, bear unevenly upon the arbor or shaft which carries it. On great clocks, and often on big clocks indoors, this counterpoise is placed inside the dial, out of sight, on the arbor. The heavier the pointer, the greater the weight required in the counterpoise; the greater the weight, the more friction on the arbor; and the more friction, the greater power required to drive the clock. By the use of aluminum pointers these drawbacks are reduced to a minimum.

THE BRITISH ASSOCIATION—ADDRESS IN ANTHROPOLOGY.

THE address in Section H was delivered by Prof. Sir W. Turner, D. Sc., F.R.S. L. and E., who selected as the subject:

SOME DISTINCTIVE CHARACTERS OF HUMAN STRUCTURE.

When we look at man and contrast his form and appearance with other vertebrate creatures, the first thing probably to strike us is his capability of assuming an attitude which we distinguish by the distinctive term "erect." In this position the head is balanced on the summit of the spine, the lower limbs are elongated into two columns of support for standing on two feet, or for walking, so that man's body is perpendicular to the surface on which he stands or moves, and his mode of progressing is bipedal. As a consequence of this, two of his limbs—the arms—are liberated from locomotor functions; they acquire great freedom and range of movement at the shoulder joint, as well as considerable movement at the elbow and between the two bones of the forearm; the hands also are modified to serve as organs of prehension, which minister to the purposes of his higher intelligence. The erect position constitutes a striking contrast to the attitude assumed by fish, amphibia, and reptiles when at rest or moving, in which vertebrates the body is horizontal, and more or less parallel to the surface on which they move. Birds, although far removed from the erect attitude, yet show a closer approximation to it than the lower vertebrates or even the quadrupedal mammals. But of all vertebrates, those which most nearly approximate to man in the position assumed by the body when standing and walking are the higher apes. The various adaptations of structure in the trunk, limbs, head, and brain which conduce to give man this characteristic attitude are essential parts of his bodily organization, and constitute the structural test which one employs in answering the question whether a particular organism is, or is not, human. These adaptations of parts are not mere random arrangements, made at haphazard and without a common purpose; but are correlated and harmonized so as to produce a being capable of taking a distinctive position in the universe, superior to that which any other organism can possibly assume. If we could imagine a fish, a reptile, or a quadruped to be provided with as highly developed a brain as man possesses, the horizontal attitude of these animals would effectually impede its full and proper use, so that it would be of but little advantage to them. It is essential, therefore, for the discharge of the higher faculties of man, that the human brain should be conjoined with the erect attitude of the body. The passage of a vertebrate organism from the horizontal position, say of a fish, in which the back, with its contained spinal column, is uppermost, and the head is in front, to the vertical or erect position of a man, in which the back, with its contained spinal column, is behind, and the head is uppermost, may be taken as expressing the full range and limit of evolution, so far as the attitude is concerned, of which such an organism is capable. Any further revolution of the body, as in the backward direction, would throw the back downward, the head backward, and would constitute a degradation. It would not be an advance in the adaptation of structure to the duties to be discharged, but rather an approach to the relation of parts existing so generally in invertebrate organisms.

ANATOMY OF MAN AND THE LOWER ANIMALS.

By the publication in 1859 of Darwin's ever-memorable treatise "On the Origin of Species by Means of Natural Selection," an enormous impulse was given to the study of the anatomy of man in comparison with the lower animals, more especially with the apes. By many anatomists the study was pursued with the view of pointing out the resemblances in structure between men and apes; by a more limited number to show wherein they did not correspond. I well remember a course of lectures on the comparative characters of man delivered 35 years ago by my old master, Prof. John Goodsir, in which, when speaking of the hand of man and apes, he dwelt upon sundry features of difference between them. The human hand, he said, is the only one which possesses a thumb capable of a free and complete movement of opposition. It may be hollowed into a cup and it can grasp a sphere. It is an instrument of manipulation co-extensive with human activity. The ape's hand is an imperfect hand, with a short and feeble thumb, and with other clearly defined points of difference and inferiority to that of man. It can embrace a cylinder as the branch of a tree, and is principally subservient to the arboreal habits of the animal. Its fingers grasp the cylinder in a series of spirals. Here, then, is an important difference in the manipulative arrangements of the two hands, the advantage being with the hand of man, in regard to the greater variety of movement and adaptability, to co-ordinate it with his reasoning faculties. As showing the acuteness of perception of Galen and his complete recognition of a fundamental feature of the human hand, he also dwells on the hand being able to form a circle around a sphere, so as to grasp it on every side, and to touch it with every part of itself, while it can also securely hold objects that possess plane or concave surfaces. If we compare the new-born infant with the young of vertebrates generally, we find a striking difference in its capability of immediately assuming the characteristic attitude of the species. A fish takes its natural posture and moves freely in its element as soon as it is hatched. A chicken can stand and walk when it is liberated from the egg, though, from its

wings not being developed, it is not at once able to fly. A lamb or calf can assume the quadrupedal position in a few minutes after birth. But, as we all know, the infant is the most helpless of all young vertebrates, and is months before it can stand on two feet and move freely on them. During the period of transition, from the stage of absolute dependence on others to the acquisition of the power of bipedal progression, important modifications in the structural arrangements both of the spine and lower limbs have to take place. At the time of birth the infant's spinal column exhibits only two curves; one, corresponding to the true vertebræ, extends from the upper end of the neck to the lowest lumbar vertebra, and the concavity of its curve is directed forward; the other and shorter corresponds to the sacro-coccygeal region, and also has its concavity directed forward. In the number and character of the curves, the new-born infant differs materially from the adult man, in whose spine, instead of one continuous curve from the neck to the sacrum, there are alternating curves, one convex forward in the region of the neck, succeeded by one concave forward in the region of the chest vertebræ, which again is succeeded by a marked convexity forward in the vertebræ of the loins. The sacro-coccygeal region continues to retain the forward concavity of the new-born child. The formation and preservation of this alternating series of curves is associated with the assumption of the erect attitude, and the development of the lumbar convexity is correlated with the straightening of the lower limbs when the child begins to walk.

THE ERECT ATTITUDE.

It has sometimes been assumed that the acquisition of the erect attitude by the young child is due to the fostering care of the mother or nurse; that it is a matter of training, encouragement, and education, without which the child would not raise itself upon its feet. I cannot, however, agree with this opinion. If one could conceive an infant so circumstanced that, though duly provided with food fitted for its nutrition and growth, it should never receive any aid or instruction in its mode of progression, there can, I think, be little doubt that when it had gained sufficient strength it would of itself acquire the erect attitude. The greater growth in length of the lower limbs, as compared with the upper, would render it inconvenient to retain the creeping or the quadrupedal position. We cannot lose sight of the important influence which, altogether independent of education, is exercised by parents on their offspring. The transmission of hereditary qualities, through the germ from which each individual organism is derived, is one of the fundamental and most striking properties of the germ plasm. Characters and peculiarities which appertain not only to the family of which the individual is a member, but also to the species to which he belongs, are conveyed through it from one generation to another. Hence, as the capability of assuming the erect attitude and of thus standing and moving on two feet have been attributes of the human form from its beginning, there can be little doubt that this power is potential in the human organism at the time of birth, and only requires a further development of the nervous and muscular systems to become a reality, without the aid of any special training. The spinal column in the region of the true vertebræ consists of numerous bones jointed together, and with disks of soft fiber cartilage interposed between and connecting the bodies of adjoining vertebræ with each other. It is to their presence that the spinal column owes its flexibility and elasticity. These disks are larger and thicker in the region of the loins, where the lumbar convexity is situated, than in other parts of the column, and there can be no doubt that the acquisition of this convexity is intimately associated with the presence of these disks. It is a matter for observation and consideration to what extent the bodies of the vertebræ contribute to the production of this curve. A few years ago Prof. Cunningham, of Dublin, and I undertook much about the same time researches into the form and dimensions of the bodies of these bones. Our observations were made independently of each other and on two different series of skeletons, and as we arrived at practically the same conclusions, we may, I think, infer that, in their main features at least, these conclusions are correct.

THE SPINAL COLUMN.

The method followed in the investigation was to measure the diameter from above downward of the body of each of the five lumbar vertebræ, both in front and behind. If the upper and lower surfaces of the bodies of the vertebræ were parallel to each other, it is obvious that, so far as they are concerned, the column formed by them would be straight, as in the case in a column built of hewn stones possessing similar parallel surfaces. But if the surfaces are not parallel, the body of the vertebra is wedge shaped; should the front of the collective series of bones have a greater vertical diameter than the back, it is equally obvious that the column would not be straight, but curved, and with the convexity forward. From the examination of a considerable number of spinal columns of Europeans, we found that, although the vertical diameter of the bodies of the two highest vertebræ was greater behind than in front, in the two lowest the anterior vertical diameter so greatly preponderated over the posterior that the anterior vertical diameter of the bodies of the entire series of lumbar vertebræ in each spine was collectively greater than the corresponding diameter of the posterior surface. In twelve European skeletons I observed that the mean difference was between 5 mm. and 6 mm. in favor of the anterior surface. If we are to regard the collective vertical diameter anteriorly of the five bones as equal to 100, the same diameter posteriorly is only equal to 96, which may be regarded as the lumbar index in Europeans. Dr. Cunningham obtained a similar index from the examination of a much larger number of European skeletons, and he further showed that in women the lumbar convexity forward is more pronounced than in men. It follows, therefore, from these observations that when the broad end of the wedge shaped bodies is in front, the bones themselves would, by their form, give a forward convexity to the spine in the lumbar region. But a similar wedge shaped form is also possessed by the lower intervertebral disks in this region, and especially by that interposed between the last lumbar vertebra and the sacrum. Hence it follows that both vertebral bodies and intervertebral disks contribute in the white races to the production of the lumbar convexity. When we pass to the examination of the corresponding region in the spines of those races of men that we are accustomed to call lower races, we find a remarkable and important difference. Let us take, as a characteristic example of a lower race, the aborigines of Australia. In their skeletons our observations have proved that the vertical diameter of the bodies of the five lumbar vertebræ was collectively deeper behind than in front. In my series of skeletons the mean difference was between 6 mm. and 7 mm. in favor of the posterior surface, so that they possessed the opposite condition to that which prevails in Europeans. Hence if the spine had been constructed of vertebræ only, instead of a lumbar convexity, the column would have possessed a forward concavity in that region. For this character, as shown in the skeleton only, I have suggested the descriptive term "Koilorachic." We know, however, that elastic disks are intercalated between the bodies of the fosseous vertebræ in the black races as well as in Europeans. It is necessary, therefore, to examine their spinal columns, when the intervertebral disks are in position, in order to obtain a proper conception of the character of the curve in the living man.

(To be continued.)

MERCURY COLUMNS.

AN accurate method of measuring the intensity of fluid or gaseous pressure is indispensable to engineers and physicists, and many forms of apparatus have been devised to meet the requirements of practical use. The Bourdon gage is most commonly used in connection with steam boilers, because it is compact and durable and is sufficiently accurate for all ordinary purposes. Gages in use about steam plants should be periodically tested, however, by comparison with some standard manometer of known accuracy, and as our regular work of boiler inspection requires us to test many thousands of gages each year, we have given considerable thought to the design and construction of standard apparatus for performing such tests with satisfactory precision. Many experimenters in physics have used manometers in which the pressure is measured by the change in volume that is experienced by a given mass of gas inclosed in a graduated glass tube of known capacity.

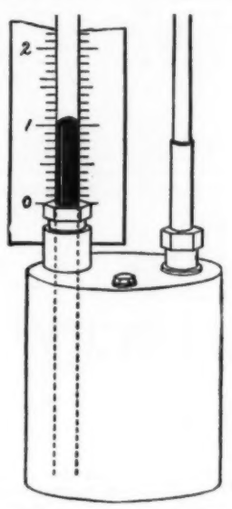


FIG. 1.—A DETAIL OF A MERCURY GAGE.

Nitrogen gas is frequently used for this purpose, because its compressibility has been studied with great care by Amagat. This method of measuring pressures has its advantages, but it has also the marked disadvantage of requiring the observer to note the temperature very accurately, because the volume of the test gas varies with the temperature so notably that a small thermometric error may introduce an error in the reading of the instrument which would be quite inadmissible. In our judgment, the gas manometer is not a satisfactory device for everyday testing purposes. It is much more satisfactory to compare the gage directly with a mercury column, and this is the method that we use in standardizing the test gages that are supplied to our inspectors. The apparatus consists in a pump, by which the gage can be subjected to a water pressure, and a long, vertical glass tube, in which mercury rises to measure the pressure. The mercury is contained in an iron reservoir, as shown in Fig. 1. Two tubes pass out through the top of this reservoir, one of which (shown on the right) transmits the water pressure from the gage table to the mercury reservoir, while the other is the glass tube already referred to, into which the mercury rises. The apparatus is so simple that it hardly needs further explanation, except on the one point of fixing the graduation marks on the scale. This appears to be simple enough, but as we have frequent letters asking how it is done, we shall explain the process of graduation in some detail. Referring to Fig. 2, let us suppose that the diagram on the left represents a little cubical vessel, one inch high, wide and deep, filled with mercury. The weight of the mercury all comes on the bottom of this vessel. Now a cubic inch of mercury weighs about 0·49 of a pound, and hence the pressure on the one square inch that forms the bottom of this little vessel would be 0·49 of a pound. Suppose, now, that we had a similar vessel which is one inch square at the bottom, as before, but which is three inches high, as shown in the middle diagram. This vessel would contain three cubic inches of mercury, and the pressure on the one square inch of its bottom side would be $3 \times 0{\cdot}49 = 1{\cdot}47$ pounds. In the same way, if we had a vessel one inch square and (say) 120 inches high, the pressure against the square inch at the bottom would be $120 \times 0{\cdot}49 = 58{\cdot}80$ pounds, and so on for any other height. Now let us consider the right hand diagram in Fig. 2. Here the vessel is supposed to be only half an inch square; but it is plain that the pressure per square inch on the bottom of the vessel would be just the same as in the middle diagram, because, although there is only one-quarter as much mercury as before, there is also one-quarter as much area on the bottom of the vessel for it to rest upon; and hence the pressure per unit of area, that is, the pressure per square inch, will be just the same in either case. It will be evident, by this same process of reasoning, that the shape of the cross section of the vessel or tube has nothing to do with the intensity of the pressure. In a word, the pressure exerted by the mercury depends upon nothing but the height of the column; and we can calculate it, in any case, just as though the column were an inch square, as we did in connection with the middle diagram of Fig. 2. In carrying out this idea in the actual work of graduation certain precautions must be observed. For example, we must make sure that the mercury is clean and pure, and that it is not contaminated with tin, or zinc, or lead, or any other substance which may affect its specific gravity. If these substances are present in appreciable amount, the weight of a cubic inch of the mercury will not be the same as the values given in the standard tables, and hence we must either purify the mercury before using it or we must weigh a cubic inch of it very accurately, so as to know by how much it departs from the standard density given in the books. It will be seen that the pressure exerted by a mercury column ten feet high will be one thing in one part of the earth and another thing in some other part. The difference is not very great, it is true, and yet it ought to be taken into account in designing mercury gages for accurate testing purposes. The expression "pounds per square inch" is illogical and meaningless, in the last analysis, although it serves well enough for the ordinary rough work of steam engineering practice. We might speak with accuracy of the number of "pounds per square inch," but this would take us too far away from the conventions of engineering practice; and as a sort of concession to the ordinary, though incorrect, use of the word "pound" as a force, we may adopt the following provisional definition of the word "pound," as it occurs in the expression "pounds per square inch." Definition:

A "pound," in estimating the pressure produced by a column of mercury, is understood to be the force with which the earth attracts a standard avoirdupois pound weight at sea level in the latitude of Washington.

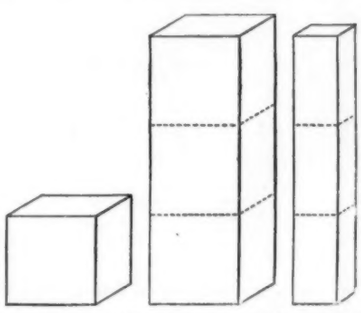


FIG. 2.—ILLUSTRATING THE PRESSURE DUE TO A COLUMN OF MERCURY.

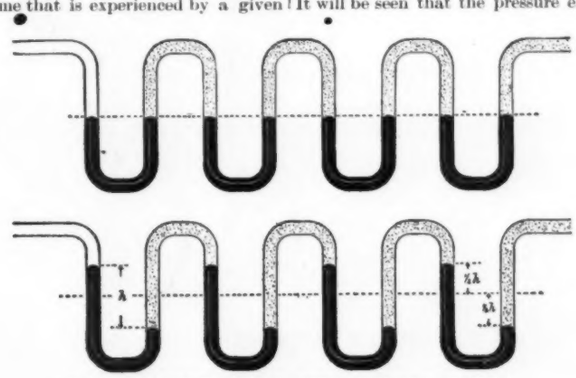


FIG. 3.—ILLUSTRATING THE "SIPHON GAGE."

With this much admitted we are ready to proceed to the problem of graduating our column. It has been found, by careful experiment, that a cubic inch of pure mercury, at 32° Fahr., has a mass of 0·49117 of a pound. Hence, according to the foregoing definition, a column of mercury one inch high gives a pressure of 0·49117 when at a temperature of 32° Fahr. at sea level in the latitude of Washington. If this one inch column of mercury were to be carried toward the equator, or up a hill or a mountain, it would produce a less pressure than this, because the earth would attract it less forcibly in those places. So, too, the pressure produced by a one inch column would be less than 0·49117 pound, if the mercury were warmer than 32° Fahr., because mercury expands upon being heated, and hence it weighs less per cubic inch at higher temperatures. To find the actual pressure produced by a one inch column of mercury, as it stands in the column in our Hartford office, we must therefore take into account three things: (1) the temperature of our column, (2) the difference in latitude between Hartford and Washington, and (3) the elevation of our office above mean sea level. The latitude of our Hartford office being 41° 46', and the temperature of the mercury column being always very near to 70°, we see from the table that it is necessary to allow 2·043 inches for each pound of pressure desired. The best way to carry out the actual work of graduation is probably to lay off, first, the positions of the marks for 10 pounds, 20 pounds, 30 pounds, etc., allowing 20·43 inches for each 10 pounds. Then the intermediate one pound divisions can be filled in upon the skeleton so laid down with great accuracy. The scale itself is best made of well seasoned and varnished pine wood, since the coefficient of expansion of pine is so small that a scale 45 feet long will vary in length by less than the thousandth part of an inch for each Fahrenheit degree of change in its temperature. The scale, when once made and graduated, is to be so adjusted that the mercury column reads accurately zero, when there is no pressure on the testing apparatus. The reading of any mercury gage that is open to the air at one end merely gives the excess of the observed pressure above that of the atmosphere. If the absolute pressure is desired, the reading of the barometer must be noted at the same time, and the atmospheric pressure, so determined, must be added to the reading of the column. When high pressures are to be determined, it is often inconvenient to read the ordinary mercury column, since the top of it is then far above the floor of the testing room. To remedy this difficulty various modifications of the column have been proposed. One of the earliest plans proposed, we believe, by Fahrenheit, is that suggested in Fig. 3. Instead of a single long column we have here a considerable number of shorter ones arranged in U-shaped tubes. The various spaces between the successive lengths of mercury are filled with water or glycerine or some other practically incompressible fluid, which serves to transmit the pressure from each body of mercury to the next. The position of the mercury when in equilibrium under atmospheric pressure at each end is shown in the upper part of the figure. When pressure is applied, the system assumes the configuration shown in the lower diagram, each U of mercury rising in one leg and falling in the other. The head due to each body of mercury is indicated on the left by the letter h, and as will be seen it is equal to double the amount by which the level has risen or fallen in any one leg. The total head of mercury in the entire apparatus is found by multiplying h by the number of U tubes that are present; and a considerable head of mercury can therefore be realized, without the necessity of extending the column to an inconvenient height. The full head, h, of the mercury in the U tubes cannot be taken in computing the pressure produced by the system, since each of the columns, h, is partially balanced by an equal column of water or glycerine, and allowance must be made for this fact.—The Locomotive

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